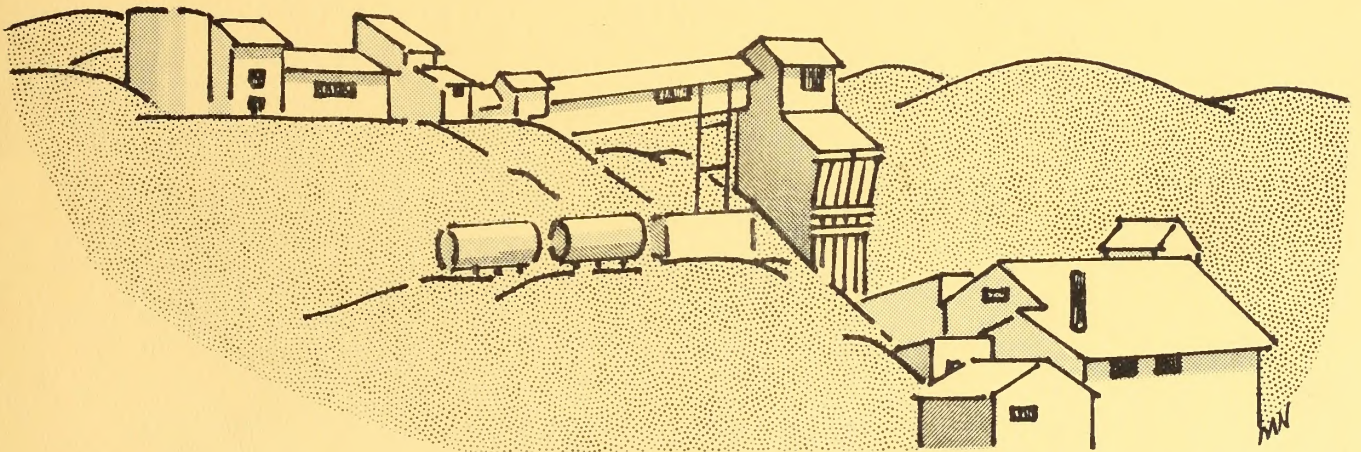


MINERAL IMPACT STUDY  
OF A  
2000 SQUARE MILE AREA  
OF THE  
EAST MOJAVE DESERT  
SAN BERNARDINO COUNTY  
CALIFORNIA

By  
J.R. Evans, Senior Technical Minerals Specialist

Prepared in cooperation with the California Division of Mines and Geology  
and the California State Mining and Geology Board



Old Sulfide Queen Mill at Mountain Pass



United States  
Department of the Interior



Bureau of Land Management  
Division of Mineral Resources  
California State Office  
Sacramento, California

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May 1986



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BUREAU OF LAND MANAGEMENT SPECIAL MINERAL REPORT

MINERAL IMPACT STUDY

OF A

2,000 SQUARE MILE AREA

OF THE

EAST MOJAVE DESERT

SAN BERNARDINO COUNTY

CALIFORNIA

By

J.R. Evans, Senior Technical Mineral Specialist  
Bureau of Land Management, California State Office  
Division of Mineral Resources  
Branch of Mining Law and Solid Minerals  
Sacramento, California

Prepared in cooperation with the California  
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California State Mining and Geology Board

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REPORT NUMBER 2100

OF 1

2,000 SQUARE FEET AREA

IN THE

EAST PART OF SECTION 36, T14N, R10E

DEER CREEK COUNTY

WYOMING

A. E. Evans, Special Agent in Charge, Bureau of Land Management, Denver, Colorado, is hereby notified that the above described land is being used for the purpose of grazing and that the same is being used for the purpose of grazing.

Witness my hand and the seal of the Bureau of Land Management at Denver, Colorado, this 1st day of May, 1954.

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## ABSTRACT

The Mineral Impact Study area consists of about 2,000 square miles (1,280,000 acres) in the east central part of the Mojave Desert, entirely within San Bernardino County. On the northeast corner, the area is bounded by the Nevada-California State line.

In the study area there is a wide variety of sedimentary, metamorphic and igneous rocks of diverse ages. Radiometric dates show that the oldest known Precambrian rocks are about 1.7 billion years old while the dating of charcoal associated with a young volcanic flow south of Halloran Springs gives a date of about 400 years.

The distribution and nature of mineral deposits closely relates to the geology of the eastern Mojave Desert and the Minerals Impact Study Area. Therefore, a general understanding of the rock units, structural framework, and types and styles of igneous intrusions with resultant rock alteration that control the formation of mineral deposits is vital for the evaluation of metallic mineral potential.

Most of the nonmetallic minerals occur as, or in, metasedimentary rocks of various geologic ages. Overburden, alteration, weathering, degree of inclination of rock units, and structural complexity of the geologic environment are critical controls that must be considered when evaluating the mineral potential of nonmetallic deposits.

Land in the Minerals Impact Study Area has been classified into Mineral Resource Zones (MRZ's) with respect to the presence, absence, or likely occurrence of mineral deposits by the California Division of Mines and Geology according to guidelines adopted by the California State Mining and Geology Board (1979, p. 23-27). The State classification is here used because it reflects current knowledge and data and was available through published and unpublished materials for the entire study area.

The eastern Mojave desert and the study area are a repository of a wide variety of mineral resources, formed under a wide range of geologic environments. These environments include deposits formed by magmatic concentration, contact metasomatism, hydrothermal activity, volcanism, sedimentation, and supergene processes. Weathering and metamorphism played a role in the enrichment of many of the deposits to convert them into substances of value, or potential value.

There is no known mineral potential for geothermal resources in the study area, and the oil and gas potential is not known. There is no recorded production of oil and gas, and only 3 wells have been drilled; west and south-southwest of Nipton in the Ivanpah Valley. However, interest in oil and gas in the Study area has been high as shown by the fact that 35 percent of it is covered by oil and gas leases. Interest probably is a result of recent geologic and seismic data that suggest that overthrust belts exist in the Mojave Desert and the study area is similar to those in the Idaho-Wyoming overthrust belt.



A total of 285 mines and prospects were identified in the area during the course of this study of which 240 are principally valued for their metal content and 45 for their non-metallic content, and used mostly for industrial uses (see Table 2).

The metallic mineral resources include; cerium group rare-earths, gold, silver, copper, lead, zinc, tungsten, molybdenum, iron, antimony, tin and accessory vanadium. The non-metallic mineral resources include; limestone, dolomite, fluorite, barite, gypsum, rare-earth elements, volcanic cinders, sericite, talc, clay, perlite, magnesite, silica, bentonite, and mica.

In 1985 California produced 2.2 billion dollars worth of non-fuel minerals and about 1.2 billion of this came from the California Desert (Bureau of Mines Mineral Industry Surveys-Mineral Industry of California, 1985, and Division of Mines and Geology). Part of this was produced from mines in the study area. In the coming decades, the California Desert and study area should be an even more important source of the mineral commodities that will aid the economy of California and the nation.

It is evident that changes in the current Desert Plan would have major and varied impacts upon future mineral development, existing mining and exploration operations, existing mineral rights holders, private land holders, the State of California, and the BLM. Based upon what has been presented, it is clear that the study area can be characterized as being highly mineralized and generally one of high and moderate mineral potential and that this information will be very helpful for future decision making.

This study was to provide some idea of the overall value and long term supply source of mineral commodities for California and the nation. There are more areas that deserve description that probably conceal a great number of deposits, if analogy can be made with the distribution of those known from the surrounding mountain ranges. However, it is beyond the scope of this report to enter into a lengthy, detailed discussion of each mineral resource area in the study area. The interested reader can find more detailed information in the files and publications of the California Division of Mines and Geology (see Evans, 1971, 1974, and 1975; Greenwood, 1983, 1984, and 1985; Hewett, 1956; Joseph, 1984 and 1985; Kohler, 1984; Wright, 1953).

#### ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the assistance of the California State Board of Mines and Geology who allowed use of unpublished geologic, and mineral data from 4 of the 9 quadrangles involved in this report. The California Division of Mines and Geology provided the above mentioned geologic and mineral data to the BLM in a speedy manner under the tight time constraints of this study. Cooperation of the Division was a vital part in preparing this report and accompanying maps. Special mention is here given to Tom Anderson, Senior Geologist and Ralph Lloyd, Geologist with the Division who were most helpful in the preparation of the report text and accompanying geologic and mineral land classification maps. Much useful information was obtained from the U.S. Geological Survey/Bureau of Mines reports and their background documents.



In the BLM, several staff members provided much needed assistance and support in a short time frame: Ken Aldridge, who compiled data and drafted most of the Plates; Peggy Cranston, who assisted Ken in the early stages of the compilation; Virgil Haven, Rod Bradley and Dale Vinton, who drafted parts of the geologic map and prepared titles and symbols; May Wakabayashi, who prepared the report cover design; and Debbie Becker, who word processed this report.

## INTRODUCTION

### Purpose of Study

This study was undertaken to gain an understanding of potential impacts upon present and future mineral development. This information will be used to analyze current minerals data and to enhance decision making with respect to the ongoing Desert Plan for the California Desert Conservation Area established by Congress in 1976. The study looks at present claims and leases with particular emphasis on ongoing mining and future potential for mineral development. A selected sample area was chosen which had current minerals data.

This information will be used in decision making by the Bureau of Land Management and Congress on suitable and unsuitable Wilderness Study Areas. The information should also be useful in connection with deliberations on the proposed "California Desert Protection Bill of 1986" (S-2061).

It was not possible with existing time constraints to study the entire Mojave Desert in the manner in which this Mineral Impact Study Area was done. This sample area was selected because current geologic and mineral land classification information was available from the California Division of Mines and Geology. The area is known to be mineralized, and it appears to be typical of the east Mojave Desert area and much of the California Desert Conservation Area.

### Background

The Federal Land Policy & Management Act of 1976 directed BLM to prepare a comprehensive multiple-use plan for the California Desert Conservation Area. This plan included an inventory and analysis of minerals and was completed in 1980 with extensive public involvement.

The plan included a process for identification and recommendations of suitable and unsuitable Wilderness Study Areas. This process includes an analysis by U. S. Geological Survey and the Bureau of Mines on areas recommended as suitable for wilderness by the Bureau of Land Management. (Approximately 25 reports have been completed to date.) These reports are being reviewed by the public to provide the Bureau of Land Management important minerals information. A significant amount of new data is also available from the State Division of Mines and Geology. All of this additional information will be used by the public, the Bureau of Land Management, the Department of Interior, and Congress to ultimately make final decisions on Wilderness Study Areas.



The Desert Plan is an ongoing process which includes an annual review. In addition, there is also an ongoing process to ultimately determine which areas of the desert will be designated as wilderness. It is imperative that these decisions be made with full understanding of ongoing and potential minerals activity. This study serves as a prototype for the type of analysis which could be done to provide the important mineral information to decision makers.

There is also proposed legislation, S-2061, which would significantly alter decisions made in the current Desert Plan. This study and its general application to other desert areas will also provide useful minerals data to the public and decision makers as they address this proposal.

### Location and Accessibility

The study area is in the east central part of the Mojave Desert, entirely within San Bernardino County (see Figures 1, and 2). On the northeast the area is bounded by the Nevada-California state line.

Interstate Highway 15 is through the central part of the area. Nevada State Highway 164 connects with Interstate 15 just south of Ivanpah Lake. The remainder of the area is partly accessible by light duty roads with hard or improved surfaces. Much of the area, however, is accessible only on narrow unimproved dirt roads, by 4-wheel drive vehicle, or by foot (see Plate 1).

### Physiography and Climate

The Mineral Impact Study Area is generally one of high and remote desert mountains with broad alluviated intermountain valleys. No cities or towns exist only small villages. To the far northeast of the area the Mesquite and Ivanpah Valleys contain lake beds, remnants of Pleistocene lakes. These lakes are Mesquite Lake and Ivanpah Lake. Clark Mountain, north of Mtn. Pass, is nearly 8,000 feet in elevation. The highest peak in the southeast part is in the New York Mountains and about 7,600 feet. In the northwest corner of the area, Kingston Peak is about 7,300 feet. Sand covered lowlands in the Devil's Playground area in the southwest part of the study area are about 1,100 feet in elevation. In the central part of the area is the broad feature called Cima Dome. It is a weathering massif upon underlying granitic rocks that terminates the south end of the Shadow Valley. A study of Plate 1 will show the interested reader the main physiographic features in some detail.

As part of the arid Mojave Desert, the study area is in a region where rainfall is very low, summers are hot, winters cold, and winds locally very strong, as much as 100 miles per hour or more. The daily range of temperatures can be high, with fluctuations during Spring months ranging from 32°F in the morning to nearly 100°F in the afternoon. In the summer, daily temperatures in low areas usually rise to 100°F, and rarely as much as 130°F or more. Below freezing temperatures are common in the high mountain regions during winter.





# INDEX MAP 1

SHOWING LOCATION OF  
THE MINERAL IMPACT  
STUDY AREA, SAN BERNARDINO  
COUNTY, CALIFORNIA



CALIFORNIA

FIGURE 1



# INDEX MAP 2



FIGURE 2



Most of the rainfall is episodic, often torrential, and occurs mostly during December to March, but heavy summer showers can occur locally. Higher regions might receive 15-inches or more of annual rainfall, but lower regions may receive only a fraction of an inch annually. Higher mountains receive an annual snowfall of several inches or more.

#### LAND AND MINERAL STATUS

Land and mineral status are important elements in decision making. Since much of the study area is under Wilderness Study Areas (WSAs) of the BLM and proposals for a future Mojave Park and/or areas roughly equivalent to the BLM WSAs, under S-2061, it is important to examine the impacts upon holders of land and mineral rights. The WSAs and the proposed Mojave Park boundaries are shown on Plate 2. Table 1 shows the status of BLM WSAs in the Mineral Impact Study Area as of May, 1986.

Plate 3 shows the land and mineral status of the study area as of May 1986. As Plate 3 is of the same scale and base as Plate 2, a comparison by section, by WSA, and so forth can be made. An overall summary of the findings in the 2,000 square mile (1,280,000 acre) study area is given below.

<u>Land Ownership and Mineral Rights</u>	<u>Acres ±</u>	<u>Square Miles ±</u>	<u>% of Study Area ±</u>
Privately owned lands	39,040	61	3
California State lands	47,153	74	4
California State Reserved mineral lands	14,388	23	1
Public lands (BLM)	1,170,918	1,830	92
Federally reserved mineral estate lands	8,501	13	0.7
Public water reserves	1,000	1.6	0.08
Oil and gas leases - BLM (492 leases are current)	450,554	704	35
Mining claims and mill sites (5,348 lode, 3,056 placer, 242 mill sites; total = 8,646)	352,650	551	28

Potential impacts on private landholders, and the State of California could be very significant as they could be generally surrounded by wilderness and/or a National Park, and mineral development would be precluded.

Most of the land is under the administration of the BLM and, as such, is public land. However, certain mineral rights prevail on the public land. Mining claims and mill sites can present a major issue when establishing a wilderness or a National Park. There were about 149,000 claims and mill sites filed in California as of May 1986. About 38,600 of these are filed for San



TABLE 1 BUREAU OF LAND MANAGEMENT (BLM)  
WILDERNESS STUDY AREAS (WSA's) PARTLY OR WHOLLY  
IN THE MINERAL IMPACT STUDY AREA

<u>NAME</u>	<u>NUMBER</u>	<u>ACRES</u>	<u>NONSUITABLE</u>	<u>SUITABLE</u>
Kingston Range	CDCA-222	256,210	229,677	26,533
No. Mesquite Mtns.	CDCA-223	23,125	23,125	0
Mesquite Mtns.	CDCA-225	44,317	44,317	0
Stateline	CDCA-225A	8,105	8,105	0
Clark Mtn.	CDCA-227	14,107	14,107	0
Hollow Hill	CDCA-228	26,422	26,422	0
Shadow Valley	CDCA-235A	10,452	10,452	0
Magee/Atkins	CDCA-237	11,092	11,092	0
Deer Springs	CDCA-237A	2,560	2,560	0
Valley View	CDCA-237B	3,200	3,200	0
Teutonia Peak	CDCA-238A	2,976	2,976	0
Cima Dome	CDCA-238B	15,333	15,333	0
Cinder Cones	CDCA-239	49,613	9,510	40,103
Old Dad Mtns.	CDCA-243	49,301	49,301	0
Rainbow Week	CDCA-244	16,019	16,019	0
Eight-Mile Tank	CDCA-245	18,714	18,714	0
Kelso Mtns.	CDCA-249	64,273	64,273	0
Kelso Dunes	CDCA-250	150,030	107,180	42,850
No. Providence Mtns.	CDCA-263	54,340	0	54,340
Mid Hills	CDCA-264	13,300	13,300	0
New York Mtns.	CDCA-265	35,583	35,583	0
Castle Peaks	CDCA-266	45,440	3,310	42,130
Table Mtns.	CDCA-270	7,556	7,556	0
Woods Mtns.	CDCA-271	37,758	37,758	0





Bernardino county, or 26 percent of the California State total. Of the 38,600 claims and mill sites, about 10,100 are in the BLM East Mojave National Scenic Area (almost the same area as the proposed Mojave Park), or 26 percent of the San Bernardino County total, and 7 percent of the State total. Of this 10,100, 8,646 are in the Mineral Impact Study Area, about 86 percent of the Scenic Area, 22 percent of the San Bernardino County total, and 6 percent of the California total. It is clear that the study area is one of high mineral interest.

If the "California Desert Protection Act of 1986" (S-2061) is passed into law, about 6,400 of the 8,646 claims and mill sites in the study area would have to be examined by the BLM for validity (and 10,100± for Mojave Park). This is so because about 60 percent of the proposed Mojave Park is within the Mineral Impact Study Area and 6,400 claims and mill sites are within the proposed park (see Figure 2). The Act requires that every unpatented mining claim located within the boundaries of the proposed parks, of which Mojave Park is one, would have to have a validity test completed within two years after passage of the Act. In addition, the estimated cost of purchasing any existing patented mining claims must also be provided Congress within the two-year period.

There is no statement in the Act about fluid and solid mineral leases, but the clear intent is to close out and preclude all forms of mineral development.

Although, there are currently no geothermal leases in the study area, there are 492 oil and gas leases covering about 450,554 acres. These leases, at an annual rent of \$1.00 per acre, bring in \$450,554 in annual income. Also they cover about 35 percent of the study area.

After a study of the land and mineral status data, it is evident that major and varied impacts would be realized upon future mineral development, existing mining and exploration operations, existing mineral rights holders, private land holders, the State of California, and the BLM.

## GEOLOGIC FRAMEWORK

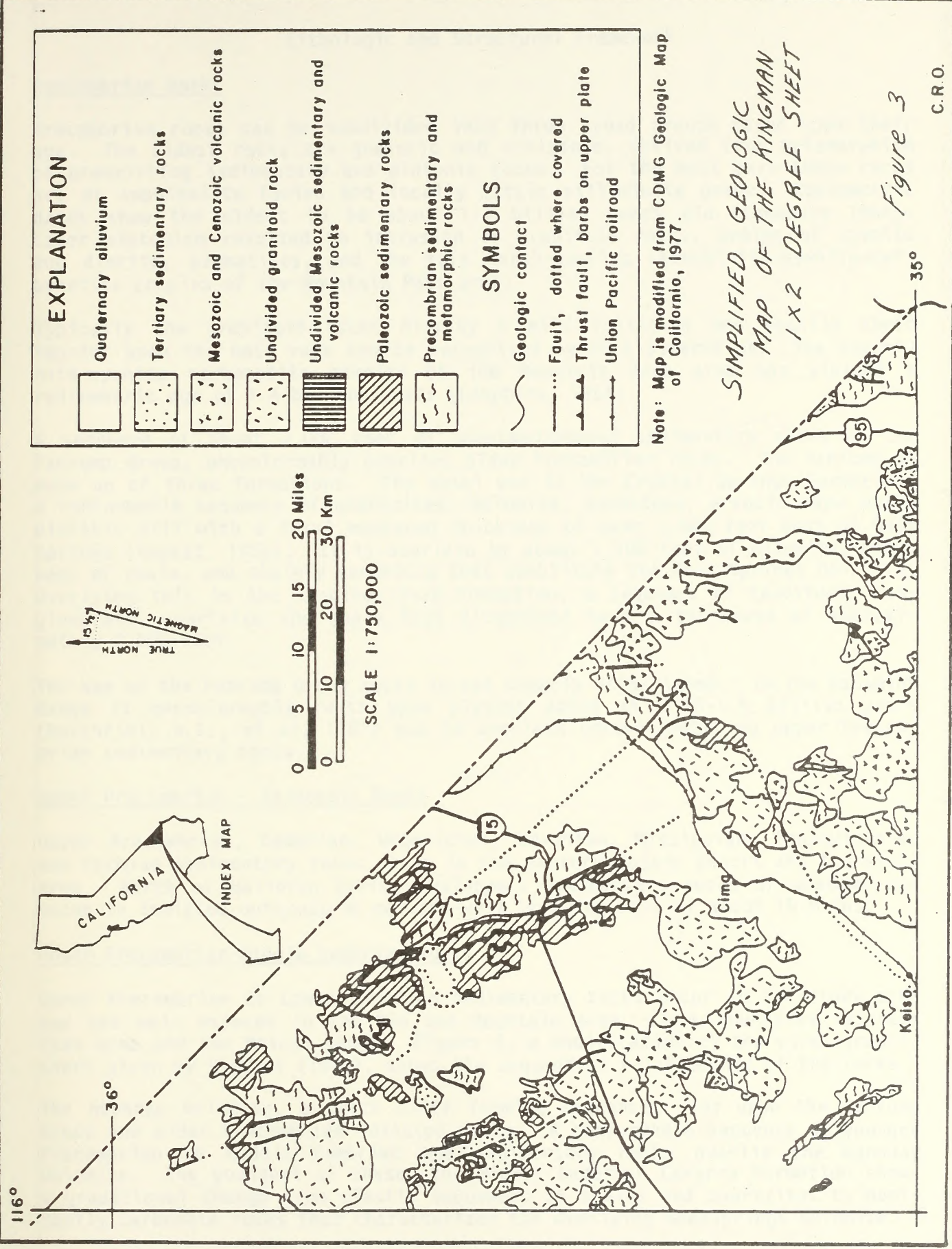
### Introduction

The distribution and nature of mineral deposits closely relates to the geology of the eastern Mojave Desert and the Minerals Impact Study Area. Therefore, a general understanding of the rock units, structural framework, and types and styles of igneous intrusions, with resultant rock alteration, that control the formation of mineral deposits, is vital for the evaluation of the metallic mineral potential.

Most of the nonmetallic minerals occur as, or in, metasedimentary rocks of various geologic ages. Overburden, alteration, weathering, degree of inclination of rock units, and structural complexity of the geologic environment are critical controls that must be considered when evaluating the mineral potential of nonmetallic deposits.

In the study area there is a diversity of sedimentary, metamorphic and igneous rocks of diverse ages. Radiometric dates show that the oldest known Precambrian rocks are about 1.7 billion years old while the dating of charcoal associated with a young volcanic flow south of Halloran Springs gives a date of about 400 years.







## Lithologic and Structural Framework

### Precambrian Rocks

Precambrian rocks can be subdivided into three broad groups based upon their age. The oldest rocks are gneissic and schistose, derived from metamorphism of preexisting sedimentary and plutonic rocks. For the most part these rocks are of amphibolite facies and locally attain silliminite grade. Radiometric dates show the oldest to be about 1.7 billion years old (Lanphere 1964). Later plutonism resulted in intrusion of granitoid rocks, bodies of syenite and diorite, pegmatites, and the rare earth-bearing skonokinite-syenite-carbonatite complex of the Mountain Pass area.

Typically the granitoid rocks display a mild foliation and locally their imprint upon the host rock can be recognized by rock alteration. The shonkinite-syenite carbonatite complex of the Mountain Pass area has yielded a radiometric age of 1.4 billion years (Lanphere, 1964).

A sequence of about 7,000 feet of unmetamorphosed sedimentary rocks of the Pahrump Group, unconformably overlies older Precambrian rocks. The Pahrump is made up of three formations. The basal one is the Crystal Springs Formation, a conformable sequence of quartzites, dolomite, sandstone, arkosic sand and a dioritic sill with a total measured thickness of over 1,900 feet east of Beck Springs (Hewett, 1956). It is overlain by about 1,100 feet of dolomite, minor beds of shale, and shaley sandstone that constitute the Beck Springs Dolomite. Overlying this is the Kingston Peak Formation, a sequence of sandstone, conglomerate, quartzite and shale that altogether have a thickness of approximately 2,000 feet.

The age of the Pahrump Group rocks is not clearly established. In the Panamint Range it unconformably rests upon plutons dated at 1.35-1.4 billion years (Burchfiel, B.C., et al, 1981) and is overlain unconformably by upper Precambrian sedimentary rocks.

### Upper Precambrian - Paleozoic Rocks

Upper Precambrian, Cambrian, Ordovician, Devonian, Missippian, Pennsylvanian and Permian sedimentary rocks occur in the eastern Mojave Desert and the study area. North of Halloran Springs Paleozoic sedimentary rocks of unknown age occur in isolated outcrops in an east-west trending belt of about 10 miles.

### Upper Precambrian-Middle Cambrian Rocks

Upper Precambrian to Lower Cambrian sedimentary rocks occur in the study area and are well exposed in the Old Dad Mountain area, Clark mountains, Winters Pass area and the Mescal Range. Figure 4, a modification of the stratigraphic chart given by Stewart (1970), shows the sequential relationship of the rocks.

The Noonday Dolomite, a thick cliff forming sequence, lies upon the Pahrump Group and older Precambrian foliated rocks. A conformable sequence of younger Precambrian to Middle Cambrian age sedimentary rocks overlie the Noonday Dolomite. The youngest of these, the Middle Cambrian Cararra Formation shows a gradational change from clastic sequences of shales and quartzites to dominantly carbonate rocks that characterizes the overlying Goodsprings Dolomite.



AGE	CENTRAL REGION	EASTERN REGION
Middle Cambrian	Carrara Formation	Bright Angel Shale
Early Cambrian	Zabriskie Quartzite	Tapeats Sandstone
	Wood Canyon Formation	
Late Pre Cambrian	Stirling Quartzite	<i>Hiatus</i>
	Johnnie Formation	
	Noonday Dolomite	
	Pahrump Group	
<i>Unconformity</i>		

Figure 4. Late Precambrian, Early Cambrian, and Middle Cambrian Sedimentary rocks in the Kingman 1 x 2 degree sheet (modified from Stewart, 1970).





In the Providence Mountains, the Latham Shale, Chambliss Limestone, and Cadiz Formation are correlative with these rocks. The rock sequences shown in Figure 4 under "Central Region" constitute several thousand feet of quartzite, siltstone, conglomerate, dolomite and limestone that thicken to the northwest. They are especially well developed in the western and northern portions of the study area. Tapeats Sandstones and overlying Bright Angel Shale occur in the eastern portion of the study area and are correlative with the Wood Canyon Formation, Zabriskie Quartzite, and Cararra Formation to the west. In the New York Mountains, the Tapeats Sandstone is approximately 300 feet thick; small exposures are present near Mesquite Pass and in the Clark Mountains. The overlying Bright Angel Shale is generally coextensive with Tapeats Sandstone. The sediments of the Tapeats Sandstone and Bright Angel Shale were probably deposited in a shallow shelf environment in the vicinity of a cratonic-miogeosynclinal boundary.

### Upper Cambrian - Permian Rocks

Paleozoic rocks younger than the Cararra Formation and Bright Angel Shale constitute 6,000 to 7,000 feet of carbonate rock and fine-grained marine clastic sediments which thicken westward and provides evidence that sedimentation in the eastern Mojave area formed in a cratonic-miogeosynclinal environment during the Paleozoic. The oldest of these platform rocks, the Goodsprings Dolomite, is thought to range from Upper Cambrian through Upper Ordovician (Gans, 1974). This unit attains a thickness as much as 1,500 in the study area, composed mainly of dolomitic rocks. It is overlain by as much as 600 feet of Devonian Sultan Limestone and from 350 feet to 700 feet of Mississippian Monte Cristo Limestone.

An unconformity separates the Pennsylvanian Bird Springs Formation from younger Paleozoic rocks. The formation is composed mostly of limestone beds, less than 20 feet thick, interbedded with shale, sandstone, and layers of chert. The overlying Pennsylvanian to Permian Supai Formation is of as much as 700 feet of sandstone, and only occurs south of Mesquite Valley in the study area. Permian age Kaibab Limestone is present near Kokoweef Peak, south of Mesquite Valley and in the Ivanpah Mountains. At this latter locale it attains a thickness of approximately 400 feet and is separated from overlying Mesozoic rocks by an unconformity.

### Mesozoic Sedimentary and Volcanic Rocks

Mesozoic sedimentary and volcanic rocks are sparsely represented in the eastern Mojave Desert and for the most part are of continental origin. Burchfiel and Davis (1981) have interpreted these rocks as having formed in a back arc environment. The oldest is the lower Triassic Moenkopi Formation, a sequence of limestone and minor amounts of shale with a maximum thickness of approximate 500 feet in the study area. It is overlain by as much as 650 feet of sandstone of the Upper Triassic Chinle Formation. The Chinle is overlain by Jurassic Aztec Sandstone, a sequence of about 1,000 feet of cross-bedded sandstone.

Upper Jurassic Mountain Pass Rhyolite (Delfonte Dacite of Hewett) is composed of about 1,200 feet of rhyolitic flows, and overlies the Aztec Sandstone in the Mescal Range (Evans, 1971). Radiometric analyses of tuff from the volcanics has yielded an age of 140 million years (DeWitt, 1982, staff communication, and DeWitt, 1980).



## Mesozoic Plutonic Rocks and the Laramide Orogeny

Mesozoic plutonic rocks are widely distributed throughout the study area and include a variety of granitoid bodies that range from granitic to dioritic in composition and are cut by felsic and mafic dikes. These rocks yield radiometric ages that range from 54 to 200 million years, representing a time span from Late Triassic through early Cenozoic for their emplacement. The oldest currently recognized rock is granodiorite from the Clark Mountain area which is 195 and 200.3 m.y. old according to K/Ar whole rock analyses (Sutter, 1968). Radiometric dates of granitic rocks at a few locales have yielded ages in the 126-168 m.y. range. However, the majority of ages cluster in the 54-110 m.y. range with the mean being 84 million years. These dates indicate major plutonic emplacement began in early Cretaceous time and had generally waned during early Tertiary time.

## Laramide Orogeny

The Laramide orogeny involves a period of widespread folding, faulting and emplacement of plutons related to mountain building in the Cordilleran region of North America during Late Cretaceous to early Tertiary time. In the study area, radiometric dates show that plutonic emplacement began in Late Triassic and continued into late Miocene, representing a time span which extends beyond the Laramide. However, most of the plutonic bodies in the area were emplaced during upper Cretaceous and early Tertiary time, and thus conforms to the generally accepted time span for the orogeny (approximately 90-58 m.y.).

Field studies coupled with evaluation of Hewett's (1956) interpretation of structural events in the study area lead to the following interpretation:

1. Initial folding of the area
2. Development of the Mescal thrust
3. Clark Mountain normal faulting
4. Mesquite overthrusting together with minor folding and faulting
5. Winters overthrust involving folding and thrust faulting
6. Major plutonic activity
7. Early normal faults
8. Dolomitization and other alteration of limestone
9. Mineralization to form most of the ore deposits present in the eastern Mojave Desert.

## Cenozoic Rocks

As mentioned previously, the youngest plutonic activity associated with the Laramide orogeny in the study area is dated at 54 million years, which indicates magma emplacement continued into Late Paleocene - Early Eocene



time. However, monzonite porphyry in the Kingston Range has yielded a radiometric age of 18.2-18.6 million years (Sutter, 1968) which indicates it was emplaced during middle Miocene.

There are no known early Tertiary sedimentary or volcanic rocks in the vicinity of the study area that suggest erosion was taking place then. Miocene sedimentary, pyroclastic, and other volcanic rocks are, however, widely distributed throughout the eastern Mojave Desert and are separated from older rocks by an unconformity. Thick sequences of Tertiary clastic flows, and related hypabyssal bodies are well exposed within the Hackberry, Castle, Shadow, New York and Providence Mountains, and at other locales. These rocks have been folded or faulted locally.

During late Tertiary, tectonic activity imposed regional effects upon the eastern Mojave Desert whereby middle Tertiary sedimentary and volcanic rocks were folded and faulted. Evidence of thrusting during late Tertiary can be found in the Kingston Range, Shadow Mountains and Old Dad Mountains.

### Quaternary Rocks and Alluvial Deposits

#### Sedimentary Rocks:

A thick succession of limey sandstone, conglomerate and pumice, which according to Hewett (1956) is at least 1,000 feet thick, occurs as scattered remnants in the Shadow Mountains and a few miles north of the Kingston Range. This succession, the Resting Springs Formation, is separated from older rock by an unconformity and is probably Pleistocene age.

#### Older Alluvium:

At numerous places in the study area, there are deposits of sand and gravel which based upon their degree of induration, composition and relationship to other nearby alluvium, indicate they had been deposited during an earlier period of alluviation. Deposits of this type are especially prominent east of Old Dad Mountain, south of the New York Mountains, along the northern boundary of the Shadow Mountains, and south of the Pahrump Valley.

#### Lake Beds:

Pleistocene age lake beds occur at Mesquite Lake, presently covering about 12 square miles, at Ivanpah Lake, at least 15 square miles, at Valley Wells, about 3 square miles, and at the south end of the Piute Range, about 1 square mile.

#### Eolian Sand:

Eolian sand is especially prominent west of Old Dad Mountain and in the area surrounding the Cowhole Mountains, and in Mesquite Valley. Elsewhere, wind-blown sand is present at scattered locales where it extends for considerable distances up mountain slopes.

#### Volcanic Rock:

Quaternary basaltic flows cover an area of roughly 40 square miles northeast of Old Dad Mountain. Included within this field are about 30 cinder cones. Volcanism began there about 10 million years ago (Katz and Boetcher, 1980)



and has continued into recent time. Katz and Boetcher (1980) report a carbon age of 330-480 years from a piece of charcoal collected from the base of one of the flows.

## RELATIONSHIP OF THE MINERAL RESOURCES TO THE GEOLOGIC FRAMEWORK

As discussed earlier, the concentration and distribution of mineral resources are intimately related to the geologic framework in which mineralization occurs. An important element of this study was to record these relationships in order to identify those areas where important mineral resources occur and to provide insight where other significant resources may exist that have not yet been recognized or discovered. The discussion which follows is to show some of the relationships that relate the mineral deposits in the eastern Mojave Desert, and the study area, to the geologic framework.

The oldest known mineralization within the area formed during the Precambrian, about 1.4 billion years ago, with the emplacement of the carbonatite complex in the Mountain Pass area. Here Union Molybdenum mines cerium group rare-earth elements. The copper-gold mineralization north of the Mountain Pass rare-earth deposit and the hydrothermal gold deposit in the Vanderbilt mine area may also have formed during the Precambrian. As yet evidence has not been obtained to firmly establish the age of mineralization.

From the Precambrian through the close of the Paleozoic the eastern Mojave area was subjected to an environment in which fine grain clastic and carbonate sediments were being deposited in a miogeosynclinal environment. The style of sedimentation changed from one wherein clastic sediments predominated to one in which chemical precipitation of carbonate sediments occurred punctuated by brief intervals of non-deposition or erosion. The overall pattern of deposition was one in which sedimentation occurred in a shallow marine shelf environment that deepened to the northwest. The deposition of clastic sediments occurred in an environment in which chemically resistant quartz-rich sediments survived stream transport to form the quartzites that are of possible economic importance in the desert area.

Sea water exchange reactions in shelf environment during the late Precambrian and Paleozoic brought about precipitation of calcium and magnesium carbonates to form bodies of dolomite and limestone that are of economic significance.

During the Late Mesozoic into early Tertiary time the Laramide Orogeny was a period of mountain building characterized by thrust faulting, normal faulting and invasion of magmatic bodies. The introduction of the magmas allowed ore forming fluid to react with Paleozoic age carbonate rock to form skarn deposits of copper, tungsten, tin, and iron with accessory gold and silver. With the introduction of heat from magmatic activity, ore forming fluids were introduced into fractures, faults, open pore spaces and other rock openings to bring about formation of hydrothermal deposits containing molybdenum, tungsten, copper, gold, silver, lead, zinc, antimony and fluorite.





Deposits of magnesite occurring in carbonate rock are spatially related to intrusion of plutonic rocks in the area and probably formed through metasomatism of the carbonate host rock. Sericite in the New York Mountains occurs in altered Mesozoic rocks and is thought to have formed through alteration by magmatic activity.

In the Old Dad Mountain area there is a possibility that hydrothermal gold mineralization is younger than the Laramide related mineralization. Gold mineralization in the Old Dad area had been localized along the Playground thrust zone. The Old Dad fault however juxtaposes Miocene-Pliocene fanglomerate against older rock and cuts the Playground thrust. Although direct evidence is not at hand, the possibility exists that gold mineralization here has been introduced along the Old Dad fault and subsequently mineralized the Playground thrust system as well, implying that gold mineralization occurred no later than the Miocene.

Volcanism extending back to Cretaceous time played an important role in the formation of low temperature hydrothermal mineral deposits. Gold mineralization in the Clark Mountains at the Colosseum mine is hosted by rhyolite in a former vent zone. In the Woods Mountain area rhyolitic rock of Miocene age hosts low temperature gold mineralization and perlite deposits. Bentonite deposits formed in old lake beds where fine grain tuffs deposited from volcanism were later altered to bentonite. South of Halloran Springs cinder cones are formed on volcanic flows. Several of these cones have been, or are now being mined.

#### MINERAL LAND CLASSIFICATION SYSTEM

Land in the Minerals Impact Study Area has been classified into Mineral Resource Zones (MRZ's) with respect to the presence, absence, or likely occurrence of significant mineral deposits by the California Division of Mines and Geology according to guidelines adopted by the California State Mining and Geology Board (1979, p. 23-27). The State classification is here used because it reflects current knowledge and data and was available through published and unpublished materials for the entire study area.

The classification scheme used on Plate 5 is given below.

- MRZ-1 Areas where available geologic information indicates there is little likelihood for the presence of mineral resources.
- MRZ-2a Areas that contain known significant mineral deposits.
- MRZ-2b Areas where there is a high likelihood that significant mineral deposits are present.
- MRZ-3a Areas that have a moderate potential for the presence of significant mineral deposits.



MR2-3b Areas where it is plausible that significant mineral deposits are present.

MR2-4 Areas with unknown mineral potential.

As defined in State Guidelines (Cal. St. Min. and Geol. Bd., p. 25-27) classification is the process of identification of lands containing significant mineral deposits. A significant mineral deposit must meet certain criteria for marketability and threshold value.

For marketability mineral deposits are divided into two categories; strategic and non-strategic. Non-strategic mineral commodities are those which are available domestically and of which the United States imports less than 65 percent of its needs, as reported annually by the Bureau of Mines. Mineral deposits in this category must be minable, processible, and marketable under the technologic and economic conditions that exist at present or which can be estimated to exist in the foreseeable future (a time span of about 50 years). Strategic mineral commodities are defined as those that are in short domestic supply and important for national defense or the well-being of the domestic economy. For purposes of State classification they are those mineral commodities of which the United States imports more than 65 percent of its needs, as reported annually by the Bureau of Mines. They are judged to be minable, processible, and marketable in the foreseeable future.

Threshold value is considered by the State to be the projected value (gross selling price) of the first marketable product from mineral deposits, and figured in terms of 1978 equivalent dollars. There are four basic categories which follow:

1. Construction materials (minimum value \$5,000,000).
2. Industrial and chemical mineral materials (minimum value \$1,000,000).
3. Metallic and rare minerals (minimum value \$500,000).
4. Non-fluid mineral fuels (minimum value \$1,000,000).

## METALLIC AND NON-METALLIC MINERAL RESOURCES

### Introduction

The eastern Mojave desert and the study area are a repository of a wide variety of mineral resources, formed under a wide range of geologic environments. These environments include deposits formed by magmatic concentration, contact metasomatism, hydrothermal activity, volcanism, sedimentation, and supergene processes. Weathering and metamorphism played a role in the enrichment of many of the deposits to convert them into substances of value, or potential value.

A total of 285 mines were identified in the area during the course of this study which includes 240 deposits of interest principally for their metal content and 45 non-metallic deposits of interest for their industrial uses (see Table 2).



TABLE 2

## LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

CLARK MOUNTAIN AND ROACH LAKE 15' QUADRANGLES				HALLORAN SPRINGS 15' QUADRANGLE			
MINE NAME	LOCATION			MINE NAME	LOCATION		
	T.	R.	S.		T.	R.	S.
<b>Gold</b>				<b>Gold</b>			
Colosseum Mine	17	13	10	Little Dove and Dove Mill Site	14	10	36
Conquistador #2	17	12	36	Raw Silver Cone No. 1	14	11	5
Fay's Claim	17	13	25 & 26	Jumbo Mine	15	9	25
Franks Claim	17	13	25	Hillside #1	15	10	4
Ivanpah Springs	17	13	24	Wanderer Ext. #3	15	10	5
Pearl	17	13	26	Wander Mine	15	10	7
White Hat	17	14	11	Arrowhead Mine	15	10	16
Unknown C	17	13	5	Robin Lee	15	10	18
Unknown C #2	17	13	5	Unnamed Shaft	15	10	18
Unknown #1	19	12	31	Lost Lead Claim Group	15	11	9
Unknown #2	18	12	29	Utah Claim Group	15	11	15
Mesquite Lake Mine	18	13	4 & 5	Telegraph Mine	15	11	16 & 17 & 20
				Unnamed Shaft	15	11	19
				Ruby - S - Mines	16	10	25
				Unnamed Prospect	16	11	33
<b>Silver</b>				<b>Copper</b>			
Allie	17	13	9	Unnamed Prospect	15	11	11
Beatrice	17	13	8 & 9	West Camp Area (formerly Toltec Mine)	16	10	31
Lizzie Bullock	17	13	9	(copper-turquoise)			
Monitor	17	13	8 & 9	Middle Camp Area (formerly Himalaya Mine)(copper-turquoise)	16	10	32 & 33
Stonewall	17	13	9	Tiffany Mine (turquoise)	16	11	33
				East Camp Area (formerly Stone Hammer Mine)(copper-turquoise)	16	11	32 & 33
<b>Lead-Zinc-Silver</b>				<b>Talc</b>			
Carbonate King (DeWitts)-Unberci	17	14	6 & 8	Calmosil Mine	15	11	3
Kalley	17	14	5	Yucca Mine	16	10	28
Keiper	17	12	25	Yucca Grove Mine (?)	16	11	9
Lime Canyon	17	13	30	Huber Claim Group No. 1-41	16	11	22
Stateline	17	14	7	Unnamed Shafts	16	11	31
Tungsten Springs (Silver)	17	13	23	Unnamed Shafts	16	11	31
Clark Mountain Mine	17	13	27	Great Wanamingo Mine	16	11	31
				Yucca Mine (formerly Pomona Mine)	16	11	33
<b>Copper</b>				<b>Tungsten</b>			
Benson	17	13	23	Unnamed Prospect	16	11	31
Calarivada	17	14	6				
Copper Commander	16	13	5				
Copper World	16	13	5				
Dewey	16	13	5				
Mammoth	17	12	14				
Unknown C #1	17	13	5				
<b>Tungsten</b>				<b>Antimony</b>			
Mojave Tungsten #1 (Green)	17	13	15	Wade	16	14	19
Mojave Tungsten #2	17	13	26				
New Benson	17	13	22 & 27				
Unknown M	17	13	22				
Tungsten Springs	17	13	23				
<b>Fluorite</b>				<b>Barite</b>			
Curtis #2	17	13	8	Unknown H	19	11	13 & 24
Korfist	17	13	22				
Pacific Fluorite Deposit	17	13	16				
Taylor	17	13	9				
Valley View	17	13	5				
#59758	17	13	8				
Unknown A	17	13	5				
Unknown B	17	13	5				
Unknown G	17	13	8				
Unknown N	17	13	21				
<b>Gypsum</b>							
Shire	17	14	6				



TABLE 2  
LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

IVANPAH 15' QUADRANGLE				KELSO 15' QUADRANGLE			
MINE NAME	LOCATION			MINE NAME	LOCATION		
	T.	R.	S.		T.	R.	S.
Gold				Gold			
Kokoweef Caverns	15	14	4	Gold Standard (formerly Minden Mine)	12	12	9
Uknow #1	15	14	9	Unnamed Prospect	13	12	27
Morning Star	15	14	21 & 28	Blue Quail #1 (formerly Jackpot Mine?)	12	12	1
Kewanee	15	14	28 & 33	Unnamed Prospect	12	12	12
Vanderbilt	14	16	3 & 4	Morning Dove #1 (former Rainbow Wells)	13	12	13
Blue Crystal	15 1/2	16	24	Morning Dove #2	13	12	24
Oro Belle	14	17	13 & 24	Rainbow Wells Prospect	13	12	13
Mountain Top	14	17	24	Unnamed Prospect	13	12	13
Hart Consolidated	14	17	24	Marl Spring	13	12	36
Valley View	14	17	24	Unnamed Prospect	13	12	36
Big Chief	14	17	24	Unnamed Prospect	11	12	15
				Tourman-Alto Lode #1	11	12	15
				Unnamed Prospect	11	12	15
				Unnamed Prospects	11	12	10
				Unnamed Prospect	11	12	11
				Unnamed Prospect	11	12	11
				Unnamed Prospects	11	12	11
				Unnamed Prospect	12	14	30
				Unnamed Prospect	12	14	29
				BAN 1-20 and Lucky Larry #1 (formerly Okaw Group)	11	13	11 & 12
				CAN 1-11 (formerly Jo Je Mine)	11	13	23
				Unnamed Prospects	11	13	23
				Unnamed Prospect	11	14	17
Copper				Iron			
Oroweef	15	14	4	Specular	11	12	15
Revenue Copper	15	14	9				
New Trail	15	14	9				
Unknown #2	15	14	15				
Allured	15	14	22				
Sunnyside	15	14	28				
Trio Group	14	16	21				
Copper Queen	14	16	30				
Tungsten				Tungsten			
Garvarza	14	15	23	Owl #1 (formerly Bright Outlook Mine)	13	13	28
Live Oak	14	16	30				
Dorr Tungsten	14	15	36				
Giant Ledge	14	16	31				
Sagamore	14	16	32				
Molybdenum				Base Metals			
Big Hunch	14	15	35	DAN #1 and #2	11	14	30
				Tough Nut Mine	11	14	30
				FAN Claim Group #1-5	11	14	19
				Unnamed Prospects	11	14	17
Limestone				Volcanic Cinders			
Meevirt Claims	14	16	9	WMK Builders Products	13	12	5 6 8
Sericite							
Rose Property	14	16	29				
Magnesite							
New Trail Deposit	15	14	15				
Rare Earth Elements							
Mineral Hill Deposit	15 1/2	14	28 & 33				
Clay							
C-1 Clay	14	17	13 & 24				
P.S. Hart Clay	14	17	24				
Huntingtop Tile	14	17	24 & 25				
Turtle Back	14	17	12 & 13				
Hart Peak #5	15	18	31				
Perlite							
Erin (Morelite Deposit)	15	18	19				
Cedar Top	15	18	30				





TABLE 2

## LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

KINGSTON PEAK 15' QUADRANGLE				MESCAL RANGE 15' QUADRANGLE			
MINE NAME	LOCATION			MINE NAME	LOCATION		
	T.	R.	S.		T.	R.	S.
Gold				Gold			
Dan Henry Mine	17	11	15	Sulfide Queen	16	13	12
Unknown	17	11	16	New Era	15	14	29
Lead-Zinc-Silver				New Era #3	15	14	20
Eastern Star Mine	17	10	17	Billy Bob	14	14	17
Gold Hill Mine	17	11	9 & 16	Teutoria	14	13	11
Golden Shadow #1 Mine	17	10	23	Lead-Silver-Zinc			
Shadow Mountain Load (sic)	17	11	21	Ginn Mine	15	14	29
Unknown	17	11	20	Wilshire	16	13	7
Unknown	17	10	26	Mohawk	16	13	7
Unknown	17	10	26	Yucca Queen	16	13	17
Unknown	17	10	7 & 13	Henry	16	13	17
Unknown	19	11	33	Budget	16	13	20
Copper				Moltusk	16	13	24
Grey Copper	17	11	16	Blue Buzzard	16	13	25
Iron Cap	19	10	34	Iron Horse	16	13	36
Shadow Mountain Mine	17	11	21	Silverado	15	14	18
Unknown	19	10	26	Agnes	16	13	27
Unknown	18	9	24	Ross	16	13	26
Clay				Unnamed #1	15	14	32
Kingston Wash Mine	18	9	26	G.A. Foyle	16	13	12
White Clay Mine	17	10	28	Copper			
Gypsum				Standard #1	15	14	18
Red Canyon	17	10	16	Standard #2	15	14	30
Talc				Johnny	15	14	30
Johnson	19	10	25 & 26	Suzanna R.	15	13	25
Mica				Copper King	15	13	25
Unknown	19	11	11 & 14	Lucky Find	15	13	25
				Tungsten			
				Silver Star	15	14	7
				Tungstite	15	14	18
				Standard #1	15	14	30
				Hartmann	15	13	25
				Tin			
				Evening Star	15	13	25
				Apex	15	13	25
				Limestone			
				Georgia Marble	15	14	18
				Volcanic Cinders			
				Cima Cinders	14	12	20
				Rare Earth Elements			
				Mountain Pass	16	13	13
				Blue Moon	16	14	31
				Bullsnake	16	13	13
				Horseshoe Group	16	14	30
				Lucky Strike	16	13	12
				Simon-Ray Mine	15 1/2	14	19
				Cake & Candy #3	16	13	11



TABLE 2

## LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

MID HILLS 15' QUADRANGLE				OLD DAD MOUNTAIN 15' QUADRANGLE			
MINE NAME	LOCATION			MINE NAME	LOCATION		
	T.	R.	S.		T.	R.	S.
<b>Gold</b>				<b>Gold-Silver-Copper-Lead-Molybdenum</b>			
Barnett Mine (Mary Creed)	12	15	11	Big Horn	13	10	35
Blue Jay #1	11	14	10	Brannigon	13	10	26
Butcher Knife Mine	13	15	5	Lucky	12	10	11
Columbia Mine	11	14	3	Comet	13	10	26
Deneb Claim	11	14	3	Oro Fino	13	10	23
GAN #3 (Frisco Claim Group?)	11	14	9	Paymaster	13	10	23
Globe Mine	11	14	9	Rainy Day	13	11	21
Golden Quail Claim Group ? (Gold Chief?)	13	16	18	Sweet	12	10	2
Gold Quartz #9	11	14	16	Unnamed Prospect	13	11	8
Gold Valley Mine	11	15	6	Unnamed Prospect	13	11	8
Good Hope Mine	11	14	21				
HML #6	11	14	4	<b>Copper-Lead-Iron</b>			
K & S Mine (Beverly Glen?)	12	15	14	Little Cowhole Mtn	13	9	35
Lost Burro Mine ?	12	15	31	Iron King	11	11	5
Peso Plata #1	12	14	35	Old Dad	12	10	13
Polaris Claim Group ?	13	16	18	Unnamed Prospect	12	9	13
Silver Buddy Claim Group (Six Claims Group)	11	14	3				
Silver Buddy Claim Group	11	14	2				
Star Mine (?)	11	14	9				
Unnamed	11	14	2				
Unnamed	11	14	3				
Unnamed	11	14	4				
Unnamed	11	14	4				
Unnamed	11	14	8				
Unnamed	11	14	9				
Unnamed	11	14	10				
Unnamed	11	15	6				
Unnamed	11	15	31				
Unnamed	12	14	21				
Unnamed	12	14	22				
Unnamed	12	14	23				
Unnamed	12	14	23				
Unnamed	12	14	27				
Unnamed	12	14	27				
Unnamed	12	14	28				
Unnamed	12	14	33				
Unnamed	12	14	34				
Unnamed	12	14	35				
Unnamed	12	15	1				
Unnamed	12	15	17				
Unnamed	12	15	17				
Unknown	12	15	17				
Unnamed	12	15	18				
Unnamed	12	15	31				
Unnamed	13	14	3				
Unnamed	13	14	3				
Unnamed	13	14	10				
Unnamed	13	14	11				
Unnamed	13	14	12				
Unnamed	13	14	14				
Unnamed	13	14	15				
Unnamed	13	14	15				
Unnamed	13	15	3				
Unnamed	14	15	34				
Unnamed	14	16	31				
Unnamed	14	16	31				
Valley View Claim	11	14	4				
Vega	12	14	34				
<b>Silver</b>							
Death Valley Mine (Dolly Varden)	13	14	11				
JAN No. 2 (Providence Mine ?)	11	14	16				
Red Rock (Perseverance ?)	11	14	28				
New York Mountains Claim Group	13	16	4				
<b>Copper</b>							
Confidence Mine (Blue Rock Claims, Pat Claims?)	11	14	4				
Francis Mine	11	14	4				
<b>Iron</b>							
Unnamed	13	15	17				
<b>Molybdenum</b>							
Summit Spring Claim Group	11	14	8 & 9 & 17				
<b>Carbonate Rock</b>							
Schiedel	12	14	11				
Snow White	14	16	31 & 32				



The metallic mineral resources include; cerium group rare-earth elements, gold, silver, copper, lead, zinc, tungsten, molybdenum, iron, antimony, tin and accessory vanadium. The non-metallic mineral resources include; limestone, dolomite, fluorite, barite, gypsum, volcanic cinders, sericite, talc, clay, perlite, magnesite, silica, bentonite, and mica.

In 1985 California produced 2.2 billion dollars worth of non-fuel minerals and about 1.2 billion of this came from the California Desert (Bureau of Mines Mineral Industry Surveys-Mineral Industry of California, 1985, and Tom Anderson (CDMG, Phone Conversation, 5-21-86)). Part of this latter amount was produced from mines in the study area. In the coming decades the California Desert and study area should be an important source of the mineral commodities that will aid the economy of California and the nation.

The following discussion highlights the occurrence and potential of these mineral resources (see Plate 5).

#### Northern Providence Mountains

The northern Providence Mountains and their extension into the Mid Hills have a high concentration of mineralized areas which are spatially related to the Providence Mountains fault system. The deposits occur in open cavity fillings along faults and fractures in Precambrian gneiss and quartz monzonite. Mineral deposits that have been identified include; 18 gold deposits, 1 silver deposit, a copper deposit and a porphyry molybdenum system. The overall pervasive nature of the Providence Mountains fault system, strongly suggests that a district wide structurally controlled mineralized system is present through the Providence Mountains, into the Mid Hills and beyond. Therefore, the system as a whole should be regarded of importance for its mineral potential. Active mineral exploration is currently in progress in this area.

#### Old Dad Mountain Area

In the northern Old Dad Mountain Area there are several gold bearing deposits that consist of vein quartz with native gold and accessory chalcopyrite in faults and fractures in Precambrian rock. Past gold production has been realized from the district and because of the extensive nature of the vein system it is likely that additional gold resources remain. Mineralization is probably of Laramide age because of the presence of quartz monzonite in close proximity to the mineralization beneath the Precambrian cover.

In the Central Old Dad Mountain area significant gold mineralization is associated with the Playground Thrust system, a major structural feature. In this area mineralization includes native gold with accessory copper occurring with quartz along with well-developed hydrothermal alteration. Elsewhere along the thrust there are a number of zones displaying hydrothermal



alternation and transported hydrated iron oxides suggesting that mineralization may be pervasively developed along the fault. Localization of gold mineralization along the Playground Thrust, past production of high grade gold from the Lucky mine which is situated in the thrust zone, existence of known gold resources at the Lucky mine, well developed hydrothermal alternation and the pervasive nature of the thrust provide evidence that a significant gold resource exists in the central Old Dad Mountain area.

The Old Dad vein deposit is in a canyon about a mile and half south of the Lucky mine in a skarn in Paleozoic carbonate rock. The deposit consists of magnetite and hematite with accessory pyrite and chalcopyrite near its western contact with carbonate rock. The deposit includes two main bodies of iron and several small ones that in total occupy a zone of about 700 feet of length and 250 feet of width. Laney (1954) provides a minimum inferred resource of 400,000 tons for the deposit. It is probable that the actual tonnage is much larger because the deposit maintains a reasonable degree of continuity at depth. Its proximity to a railroad a few miles to the south provides additional interest for the deposit.

Elsewhere in the central Old Dad Mountain area and the nearby Cowhole Mountains there are Paleozoic age carbonate rocks and quartzite with possible significant resource value.

#### New York Mountains

There are several mineralized areas in the central New York Mountains which include deposits of molybdenum, copper, tungsten, silver, lead, zinc, fluorite, carbonate rock and sericite.

The most prominent of these is a porphyry molybdenum deposit which includes a zone containing notable development of stockwork quartz rock that carries molybdenite, pyrite and chalcopyrite enclosed by hydrothermally altered Laramide age quartz monzonite. The area is laced with a number of quartz veins that contain varying amounts of copper, lead, zinc, fluorite and accessory gold and silver.

On the northeast side of the New York Mountains a deposit of sericite is held by Pfizer, Inc., that has yielded production in recent time. The deposit occurs in a northeast trending series of altered metavolcanic rock.

Limestone and dolomite occur in the Sagamore mine area in the eastern New York Mountains, in Paleozoic age carbonate rock. According to test data provided by the owner, Pluess-Staufer, Inc., this deposit is of sufficient quality to be used as a raw material for the chemical and plastics industry.

#### Halloran Summit Area

Two significant mineral areas occur in the Halloran Summit area, including a gold and talc deposits.





The gold bearing area includes the Telegraph mine, the Lost Lead claim group and other nearby mine workings. Mineralization include 2 parallel stockwork veins in silicified quartz monzonite, that follow a northeast trend. During the period 1932 to 1948 the deposit yielded over 2,800 ounces of gold, Recent drilling by Cascade Energy and Minerals Corporation show that significant tonnages of gold-bearing vein matter remain in the mine area. Additional mineralized ground extends beyond the area for which gold resources have been established.

Talc deposits are about 2.5 miles northeast of the Telegraph mine and include the Yucca Grove Mine. They consist of two roughly parallel massive, blocky beds of tremolitic talc. Where exposed, the talc trends N 55 W and can be traced for about 2,000 feet. Data submitted by the mine operator coupled with field study of the area indicate that a significant body of talc is available.

### Cima Volcanic Field

The Cima Volcanic field, is in the east central part of the study area, is about a 40 square mile area of basaltic lava beds and attendant cinder cones. Cinders from the cones are currently being mined and several of the remaining cones contain similar material. The overall tonnage available at the site where mining is active constitutes a significant resource of this material.

### Mescal Range

The Mescal Range is the locus of the most important skarn system in the east Mojave desert. In addition, significant undeveloped carbonate rocks occur in the range.

The Mescal Range skarn system can be traced for a linear distance of at least 10 miles along its northerly trend on the west side of the range. Deposits contain tungsten, copper and tin bearing minerals along with magnetite, epidote, garnet, serpentine, pyroxine, chlorite and quartz. Skarn occurs in Paleozoic carbonate rock adjacent to its contact with quartz monzonite. To the north and west of the main skarn zone is an area in which there are at least 9 silver-lead-zinc deposit with accessory copper that are considered to be skarn related because they possess some of characteristics of mineral assemblages that typify both skarns and hydrothermal deposits. The main skarn system includes 16 individual mineralized locales and has a history of past production, overall continuity, and the presence of inferred resources. The Mohawk mine area has a history of past production and known resources of significance remaining. In addition, based upon the geology of the area there is a fair chance that lateral extensions of known mineralization extends to the north beneath the alluvium.

A magnetometer survey of the main skarn system that was conducted with the field study by California Division of Mines and Geology showed a strong magnetitic anomaly extending for a distance in excess of a 1,000 feet beyond the skarn that could be directly correlated with one of the mines from which production had been realized in the past.



A significant carbonate rock deposit held by Georgia Marble Company occurs on the east slopes of Striped Mountain a short distance south of the Mescal Range. The deposit is Paleozoic carbonate rocks of the Goodsprings Dolomite, Sultan Limestone and Monte Criste Limestone, and extends for a distance of about 2 miles along a northern trend and averages approximately 0.5 miles in width. Data provided by the Georgia Marble Company indicates the deposit contains high quality limestone and dolomite. Because of the extensive size of the deposit, its local high quality and overall continuity it is regarded as an important deposit.

Elsewhere in the Mescal Range there are local hydrothermal gold and silver-lead-zinc deposits that occupy faults in quartz monzonite, however, information is not available to determine if any are significant. In addition to these deposits, there are wide expanses of Paleozoic carbonate rock that may represent significant mineral resources. However, there is insufficient sample and test data to determine their significance.

### Clark Mountain Area

The Clark Mountain area is a highly mineralized and hosts deposits of cerium group rare-earth elements, gold, silver, antimony, lead, silver, zinc, copper, fluorite, silica, gypsum and limestone.

Without doubt the most well known mineralization in the eastern Mojave Desert is the rare-earth element mineral deposit in the Mountain Pass area at the south end of the Clark Mountain. In April 1949, a vein containing bastnaesite ( $\text{REFCO}_3$ ), a fluocarbonate of cerium group rare-earths, was discovered near the Sulphide Queen gold mine. Subsequent prospecting led to the discovery of numerous veins, dikes, sills and a main body of carbonatite in Precambrian gneiss and schist in a northwestward-trending belt about 7 miles long and a mile wide. The veins and main carbonatite body are characterized by barite, strontianite, calcite, quartz, galena, bastnaesite, fluorite, crocidolite, and other minerals. The main carbonatite body is a north trending sill with a maximum dimension of 700 feet (Evans, 1966). Production by Union Molycorp, Inc., from this ore body represents a major contribution to the world supply of cerium group rare-earth elements. The deposit which is the largest known one of its kind in the world has sufficient reserves to continue to be a global supplier of rare-earths for a considerable time into the future.

In a number of areas around Mountain Pass there are exposures of fenitized (sodium and potassium metasomatized) country rock representing a characteristic type of alternation associated with carbonatities. Areas in which fenitized rocks occur provide indirect evidence that additional rare-earth element mineralization may be present.

Approximately 6 miles northeast of the Mountain Pass deposit is another important mineral resource area, the site of the Colosseum mine. The deposit consists of two hydrothermally altered Mesozoic age rhyolite breccia pipes. The pipes are approximately 500 feet wide by 700 feet in length and connect at depth. The breccia pipe contains disseminated gold and altered fragments of a variety of older rock types. The deposit consists of several million tons of gold bearing rock comparable in grade to other deposits being mined elsewhere in the western United States.



## Kingston Wash

A high quality bentonite deposit is currently being mined by American Colloid Company about one-half mile south of Kingston Wash near the western boundary of the study area. The deposit occurs in Tertiary lake beds that trend east-west and dip about 25° north. Sufficient bentonite of high quality exists in the deposit to be considered a significant resource.

## Perspective View

This brief excursion through some of the more important known mineral resource areas of the study area was to provide some idea on its overall value as a long term supply source of mineral commodities for California and the nation. There are many more areas here that probably conceal a great number of deposits, if analogy can be made with the distribution of those known from the surrounding mountain ranges. However, it is beyond the scope of this report to enter into a lengthy, detailed discussion of each mineral resource area. The interested reader can find more detailed information in the files and publications of the California Division of Mines and Geology (see Evans, 1971, 1974, and 1975; Greenwood, 1984, 1984, and 1985; Hewett, 1956; Joseph, 1984, and 1985; Kohler, 1984; Wright, 1953). However, based upon what has been presented it is clear that the study area can be characterized as highly mineralized and one that contains many areas of high and moderate mineral potential.

## FLUID MINERAL RESOURCES

There is no known potential for geothermal resources. An examination of recent geothermal maps of California show no hot springs on areas of abnormal heat flow within the Mineral Impact Study Area (Higgins and Martin, 1980, and Majmundar, 1983).

Oil and gas potential is not known. There is no recorded production, and only 3 oil and gas wells have been drilled in the study area (California Division of Oil and Gas, Well Summary Reports, 1970). These wells are in the Ivanpah Valley west and south southwest of Nipton. They are:

Ramseyer 1-35; TD 3,500'; S. 35, T. 16 N., R. 15 E.; OG shows reported  
Ivanpah 1-23; TD 2,440'; S. 23, T., 15½ N., R. 15 E.; OG shows reported  
Ivanpah 13; TD 6,502'; S. 5, T., 15 N., R. 16 E.

In the Ivanpah Valley, however, seismic refraction, gravity and magnetic measurements show as much as 8,000 feet of fine to medium grained clastic rocks in an asymmetrical graben (Carlisle and others, 1980).

Interest in oil and gas by individuals and by oil and gas companies in the Mineral Impact Study Area has been high as shown by the fact that 35 percent of it is covered by oil and gas leases. Interest probably is a result of recent geologic and seismic data that suggest that overthrust belts similar to those in the Idaho-Wyoming overthrust belt exist in the Mojave Desert and the study area (Calzia and others, U.S. Geological Survey, unpublished administrative report, 1981).



## SELECTED REFERENCES

- Barca, R.A., 1966, Geology of the northern part of Old Dad Mountain Quadrangle, San Bernardino County, California: Map Sheet 7, California Division of Mines and Geology.
- Beckerman, G.M., 1982, Petrology of the southern portions of the Teutonia batholith, a large intrusive complex of Jurassic and Cretaceous age in the eastern Mojave Desert, California: M.S. Thesis, University of Southern California.
- Beckerman, G.M., Robinson, J.P., and Anderson, J.L., 1982, The Teutonia batholith, a large intrusive complex of Jurassic and Cretaceous age, in the eastern Mojave Desert, California, Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada: San Diego, Cordilleran Publishers, p. 205-220.
- Bell, R.E., 1971, Geology of the Shadow Mountains area, eastern San Bernardino County, California: M.S. Thesis, San Diego State University.
- Bowen, O.E., Gray, C.H., and Evans, J.R., 1973, The Mineral Economics of the Carbonate Rocks: California Division of Mines and Geology, Bulletin 194.
- Burchfiel, B.C. and Davis, G.A., 1971, Clark Mountain thrust complex in the cordillera of southeastern California: Geologic summary and field trip guide, University of California, Riverside Campus Museum Contribution, no. 1, p. 1-28.
- Burchfiel, B.C. and Davis, G.A., 1977, Geology of the Sagamore Canyon-Slaughterhouse Spring area, New York Mountains, California: Geological Society of American Bulletin, v. 88, No. 11, p. 1623-1640.
- Burchfiel, B.C. and Davis, G.A., 1981, Mojave Desert and environs, in Ernst, G.W., editor, The geotectonic development of California, Rubey Volume 1, Prentice Hall, Inc., Englewood Cliffs, New Jersey, p. 217-251.
- California State Mining and Geology Board, 1983, California surface mining and reclamation policy and procedures: California Division of Mines and Geology Special Report 51 (2nd rev.), 38 p.
- Carlisle, C.L., Luyendyk, B.P., and McPherron, R.L., 1980, Geophysical survey in the Ivanpah Valley and vicinity, eastern Mohave Desert, California, in Fife, D.L., and Brown, A.R., eds., Geology and mineral wealth of the California Desert: South Coast Geological Society, p. 485-494.
- Crosby, III, J.W. and Hoffman, S.R., 1951, Fluorspar in California: California Journal of Mines and Geology, v. 47, no. 4, p. 619-638.
- DeWitt, E., 1980, Geology and geochronology of the Halloran Hills, southeastern California, and implications concerning Mesozoic tectonics of the southwestern cordillera: Ph.D. Thesis, Pennsylvania State University.





- Department of the Interior, 1980, The California desert conservation area plan: Government Printing Office Publication 790-357, 29 p.
- Dobbs, P.H., 1961, Geology of the central part of the Clark Mountain Range, San Bernardino County, California: M.S. Thesis, University of Southern California.
- Dunne, G.C., 1972, Geology of the Devil's Playground area, eastern Mojave Desert, California: Ph.D. dissertation, Rice University.
- Evans, J.R., 1961, Volcanic cinders near Baker: Mineral Information Service, v. 14, no. 9, p. 10-11.
- Evans, J.R., 1966, California's Mountain Pass mine now producing europium oxide: Mineral Information Service, v. 18, no. 2, p. 23-32.
- Evans, J.R., 1971, Geology and mineral deposits of the Mescal Range quadrangle, San Bernardino County, California: California Division of Mines and Geology Map Sheet 17.
- Evans, J.R., 1974, Relationship of mineralization to major structural features in the Mountain Pass area, San Bernardino County, California: California Geology, v. 26, no. 7, p. 147-157.
- Evans, J.R., Bowen, O.E., Gray, C.H., Jr., 1975, Carbonate rock resources of the Striped Mountains Area, San Bernardino County, California: California Division of Mines and Geology Map Sheet 25.
- Fife, D.L., Brown, A.R., eds., Geology and mineral wealth of the California Desert: South Coast Geological Society, 555 p.
- Gans, W.T., 1974, Correlation and redefinition of the Goodsprings Dolomite, southern Nevada and eastern California: Geological Society of America Bulletin, V. 85, no. 2, p. 189-200.
- Gese, D.D., 1984, Mineral investigation of the Castle Peaks Wilderness Study Area (CDCA-266), San Bernardino County, California: Bureau of Mines MLA 9-84, 49 p.
- Greenwood, R.B., 1984, Mineral land classification of the Halloran Spring 15' quadrangle, San Bernardino County, California: California Division of Mines and Geology Open File Report 84-51 LA.
- Greenwood, R.B., 1984, Mineral land classification of the Kelso 15' quadrangle, San Bernardino County, California: California Division of Mines and Geology Open File Report 84-3 LA.
- Greenwood, R.B., 1985, Mineral land classification of the Mid Hills 15' quadrangle, San Bernardino County, California: California Division of Mines and Geology Open File Report 85-8 LA.
- Hazzard, J.C., 1937, Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California: California Division of Mines, Journal Mines and Geology, v. 33, no. 4, p. 273-339.



- Healy, D.L., 1973, Bouguer Gravity Map of the Kingman Sheet: California Division of Mines and Geology, scale 1:250,000, 6 p. text.
- Hewett, D.F., 1931, Geology and ore deposits of the Goodsprings quadrangle, Nevada: U.S. Geological Survey Professional Paper 162, 172 p.
- Hewett, D.F., 1948, Iron deposits of the Kingston Range, San Bernardino County, California: California Division of Mine Bulletin 129, pp. 139-206.
- Hewett, D.F., 1956, Geology and mineral resources of the Ivanpah quadrangle, California and Nevada: U.S. Geological Survey Professional Paper 275, 172 p.
- Higgins, C.T., and Martin, R.C., 1980, Geothermal map of California: California Division of Mines and Geology Geologic Data Map no. 4, scale 1:750,000.
- Jaffe, H.W., 1955, Precambrian monazite and zircon from the Mountain Pass rare-earth district, San Bernardino County, California: Geological Society of America Bulletin, v. 66, p. 1247-1256.
- Jennings, C.W., 1961, Geologic map of California, Olaf P. Jenkins edition, Kingman sheet, scale 1:250,000.
- Joseph, S.E., 1984, Mineral land classification of the Mescal Range 15' quadrangle, San Bernardino County, California: California Division of Mines and Geology Open File Report 84-2 LA.
- Joseph, S.E., 1985, Mineral land classification of the Ivanpah-Crescent Peak-Searchlight 15' quadrangles, San Bernardino County, California: California Division of Mines and Geology Open File Report 85-7 LA.
- Kohler, S.L., 1984, Mineral land classification of the Lanfair Valley, Homer Mountain, and Davis Dam quadrangles, San Bernardino County, California: California Division of Mines and Geology Open File Report 84-30 SAC.
- Labotka, T.C., 1977, Late Precambrian depositional environment of the Pah-rump Group, Panamint Mountains, California: California Division of Mines and Geology Special Paper 129, p. 93-100.
- Lanphere, M.A., 1964, Geochronological studies in the eastern Mojave Desert, California: Journal of Geology, v. 72, p. 381-399.
- Logan, C.A., 1947, Limestone in California: California Journal of Mines and Geology, v. 43, p. 175-357.
- McMackin, M.R., 1983, Geology of the Kingston Range area: U.C. Davis, unpublished summer camp field study, 1982-1983, scale 1:40,000.
- Majmundar, H.H., 1983, Technical map of the geothermal resources of California: California Division of Mines and Geology, Geologic Data Map no. 5., scale 1:750,000.



- Munger, A.H., April 1986, Munger Map Book - California and Alaska oil and gas fields.
- Munts, S.R., 1983, Mineral investigation of the Kelso Dunes Wilderness Study Area (CDCA-250), San Bernardino County, California: Bureau of Mines MLA 107-83, 16 p.
- Noble, L.F., 1934, Rock formations of Death Valley, California: Science, v. 80, no. 2069, p. 173-178.
- Nolan, T.B., Merriam, C.W., and Williams, J.S., 1956, The stratigraphic section of the vicinity of Eureka, Nevada: U.S. Geological Survey Professional Paper 276, 77 p.
- Novitsky-Evans, J., 1978, Geology of the Cowhole Mountains, southeastern California, structural stratigraphic and geochemical studies: Ph.D. dissertation, Rice University.
- Olson, J.C., Shawe, D.R., Pray, L.C., and Sharp, W.N., 1954, Rare earth mineral deposits of the Mountain Pass district, San Bernardino County, California: U.S. Geological Survey Professional Paper 261, 75 p.
- Page, L., in preparation, Geology of northwestern Horsethief Spring 15' Quadrangle: M.S. Thesis, University of California, Davis.
- Park, Stephen, and others, 1985, A geophysical study of Mesquite Valley: Nevada-California Border: Journal of Geophysical Research, v. 90, no. B10, p. 8685-8689.
- Pray, L.C., 1957, Rare earth elements: California Division of Mines Bulletin 176, p. 467-474.
- Robinson, J.P., 1979, Petrology and petrochemistry of granitic intrusives of the Cima Dome-Ivanpah Mountains area, southeastern California: M.S. Thesis, University of Southern California.
- Rumsey, C.M., and McMahan, A.B., 1985, Mineral resources of the Cinder Cones Wilderness Study Area (CDCA-239), San Bernardino County, California: Bureau of Mines MLA 67-85, 12 p.
- Sharp, J.E., 1984, A gold mineralized breccia pipe complex in the Clark Mountains, San Bernardino County, California: Arizona Geological Society Digest, v. 15, p. 119-139.
- Stewart, J.H., 1970, Upper Precambrian and Lower Cambrian strata in the southern Great Basin, California and Nevada: U.S. Geological Survey Professional Paper 620, 206 p.
- Sutter, J.F., 1968, Geochronology of major thrusts, southern Great Basin, California, Rice University: Unpublished M.S. Thesis, 32 p.
- Tucker, W.B., 1921, San Bernardino County: California Mining Bureau Report 17, p. 333-374.



- Tucker, W.B. and Sampson, R.J., 1930, San Bernardino County: California Division of Mines Report 26, p. 202-325.
- Tucker, W.B. and Sampson, R.J., 1940, Current mining activity in southern California: California Division of Mines Report 36, p. 9-82.
- Tucker, W.B. and Sampson, R.J., 1943, Current Mining activity in southern California: California Division of Mines Report 39, p. 118-138.
- Tucker, W.B. and Sampson, R.J., 1943, Mineral resources of San Bernardino County: California Division of Mines Report 39, p. 427-549.
- U.S. Bureau of Land Management, 1980, The California Desert Conservation area plan 1980.
- U.S. Bureau of Land Management, 1985, Microfiche listing of unpatented mining claims in California.
- U.S. Bureau of Mines, undated, Mineral Industry Location System (MILS); files for San Bernardino County.
- U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals; U.S. Geological Survey Circular 831, 5 p.
- U.S. Geological Survey, 1983, Aeromagnetic map of the Kingman-Trona area, California: U.S. Geological Survey Open-File Report 83-663, scale 1:250,000.
- U.S. Geological Survey, Branch of Resources Analysis, 1979, Mineral Data System Computerized Resource Information Bank (MDS-CRIB); files for San Bernardino County.
- Ver Planck, W.E., 1966, Quartzite in California: California Division of Mines and Geology, Bulletin 187, 58 p.
- Weisenberg, C.W., 1973, Petrology and structure of the Ivanpah Mountains area, California: M.S. Thesis, Rice University.
- Wilson, R.C., Jr., 1966, The structural geology of the Shadow Mountains area, San Bernardino County, California: M.A. Thesis, Rice University.
- Wright, L.A., 1968, Talc deposits of the southern Death Valley-Kingston Range Region, California: California Division of Mines and Geology, Special Report 95, 79 p.
- Wright, L.A., Stewart, R.M., Gay, T.E., Jr., and Hazenbush, G.C., 1953, Mines and mineral deposits of San Bernardino County, California: California Journal of Mines and Geology, v. 49, p. 49-259.
- Wright, L.A., and Troxel, B.W., 1967, Limitations on right lateral strike-slip displacement, Death Valley and Furnace Creek fault zones, California: Geological Society of America Bulletin, v. 78, no. 8, p. 933-949.





Wright, L.A., Troxel, B.W., Williams, E.G., Roberts, M.T., Diehl, P.E., 1976, Precambrian sedimentary environments of the Death Valley Region, eastern California, in Geologic Features Death Valley, California: California Division of Mines and Geology Special Report 106, p. 7-15.

Yeend, W., Dohrenwend, J.C., Smith, R.S.U., Goldfarb, R., Simpson, R.W., Jr., and Muntz, S.R., 1984, Mineral resources and mineral resource potential of the Kelso Dunes Wilderness Study Area (CDCA-250), San Bernardino County, California: U.S. Geological Survey Open-File Report 84-647, 19 p.

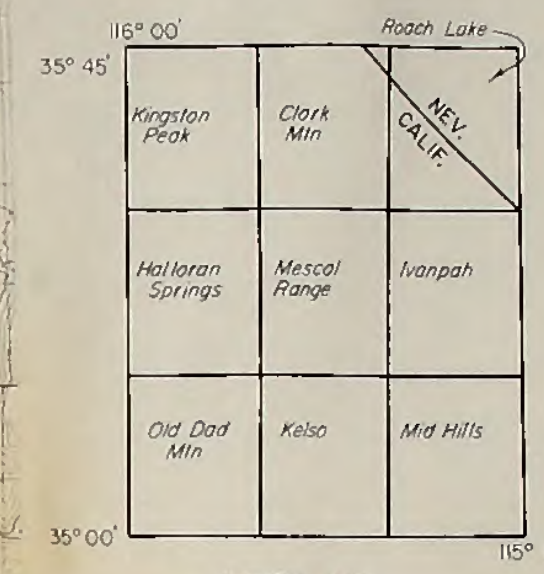


# PLATE 1 MAP SHOWING TOPOGRAPHY IN THE MINERAL IMPACT STUDY AREA

San Bernardino County, California  
1986

### EXPLANATION

- Mineral Impact Study Area Boundary
- - - Proposed Mojave Park Boundary



INDEX MAP  
For Minerals Impact Study Area  
by U.S. Geological Survey Quadrangle

### Topographic Map Symbols

- Primary highway, hard surface
- Secondary highway, hard surface
- Light duty road, principal street, hard or improved surface
- Dirt road or street, 192'
- Railroad, standard gauge, narrow gauge
- Bridge, overpass, underpass
- Tunnel, rail, vehicular
- Bank of river, locality, elevation
- Airport, landing field, landing strip
- National boundary
- State boundary
- County boundary
- National of State reservation boundary
- Land grant boundary
- U.S. public lands survey range, township, section
- Range, township, section line, projected
- Fence, reservation line, pipeline
- Dam, dam with lock
- Cemetery, building
- Windmill, water well, spring
- Mine shaft, salt or ore, mine, quarry, gravel pit
- Campground, picnic area, U.S. location monument
- Rune, cliff dwelling
- Disturbed surface, strip mine, brick, sand
- Culture, index, intermediate, supplementary
- Settlement, contour, index, intermediate
- Stream, lake, perennial, intermittent
- Reservoir, large and small, lake, large and small
- Area to be submerged, marsh, swamp
- Land subject to controlled reclamation, woodland
- Creek, meanders
- Quarry, vineyard

CONVERSION TABLE

Meters	Feet
1	3.2808
2	6.5617
3	9.8425
4	13.1234
5	16.4042
6	19.6850
7	22.9659
8	26.2467
9	29.5276
10	32.8084

For correct meters to feet multiply by 3.2808  
To convert feet to meters multiply by 0.3048

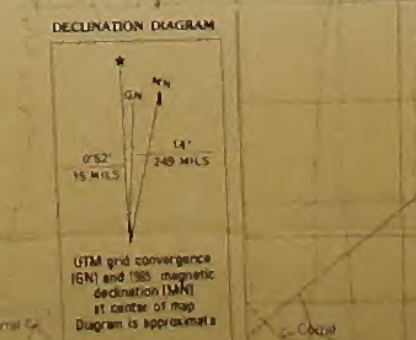
DECLINATION DIAGRAM

UTM grid convergence (ISN) and 1983 magnetic declination (M) at center of map. Diagram is approximate.

Produced by the United States Geological Survey  
**MESQUITE LAKE**  
Compiled from USGS 1:62,500-scale topographic maps dated 1955-1960. Planimetry revised from aerial photographs taken 1976 and other source data. Revised information not field checked. Map edited 1985.

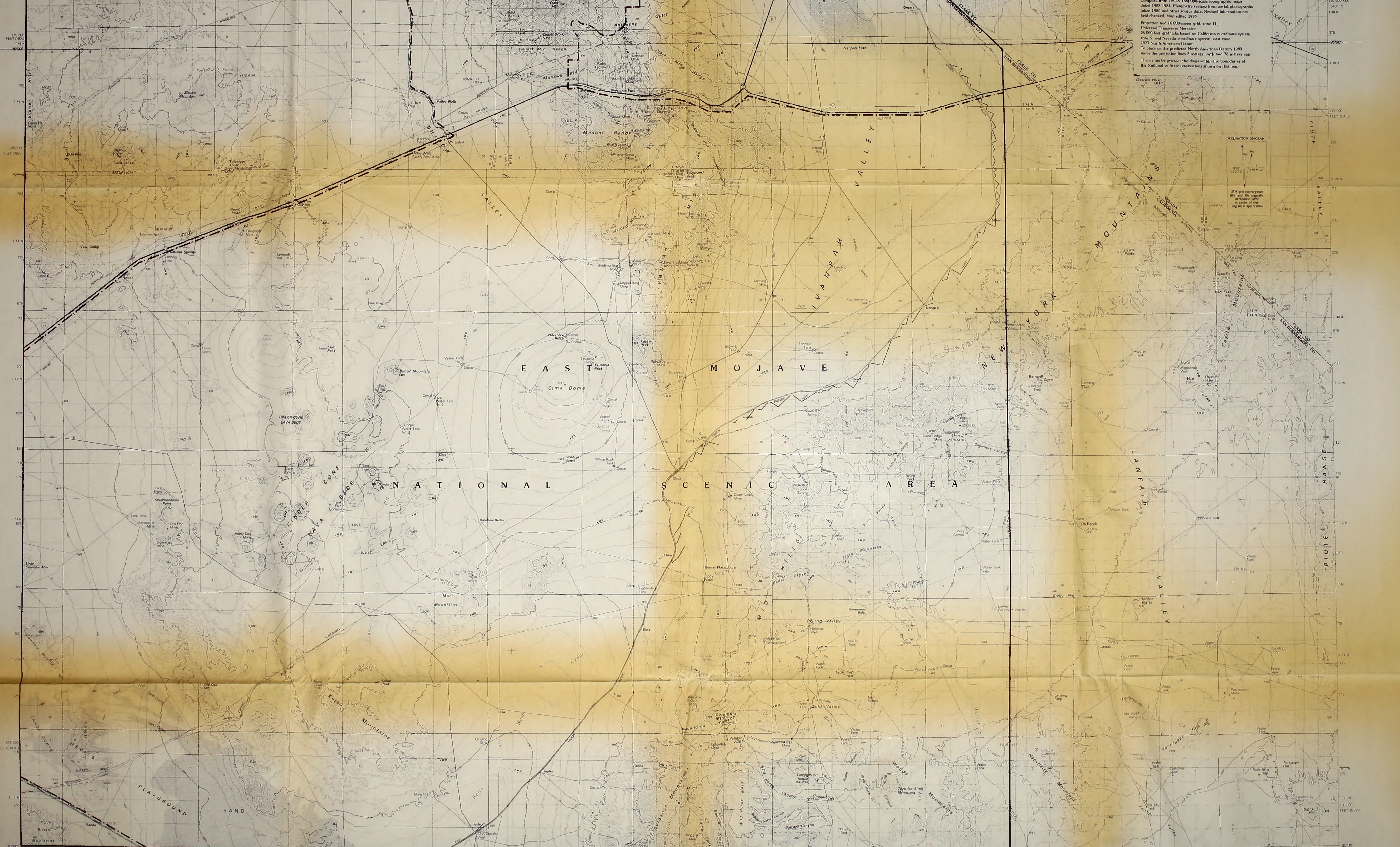
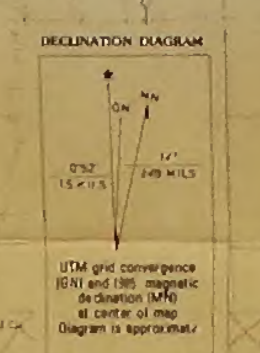
**IVANPAH**  
Compiled from USGS 1:24,000-scale topographic maps dated 1963-1984. Planimetry revised from aerial photographs taken 1980 and other source data. Revised information not field checked. Map edited 1985.

Projection and UTM grid: UTM zone 11, Universal Transverse Mercator  
25 000-foot grid ticks based on California coordinate system, zone 5, and Nevada coordinate system, east zone 1927 North American Datum  
To place on the predicted North American Datum 1983, move the projection lines 3 meters north and 70 meters east  
There may be private inholdings within the boundaries of the National or State reservations shown on this map.



EAST MOJAVE NATIONAL SCENIC AREA

IVANPAH  
Compiled from USGS 1:62,500-scale topographic maps dated 1955-1960. Planimetry revised from aerial photographs taken 1974 and other source data. Revised information not field checked. Map edited 1985.  
Projection and 10,000-meter grid, zone 11, Universal Transverse Mercator  
25,000-foot grid ticks based on California coordinate system, zone 5, and Nevada coordinate system, east zone 1927 North American Datum  
To place on the projected North American Datum 1983 move the projection lines 3 centimeters north and 74 centimeters east  
There may be private holdings within the boundaries of the National or State reservations shown on this map



MESQUITE LAKE, NEV.—CALIF.  
1978

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY



MESQUITE LAKE QUADRANGLE  
NEVADA—CALIFORNIA  
1:100 000-SCALE SERIES (PLANIMETRIC)

# MAP SHOWING CALIFORNIA DESERT CONSERVATION AREA WILDERNESS STUDY AREA BOUNDARIES AND NUMBERS FOR THE MINERAL IMPACT STUDY AREA

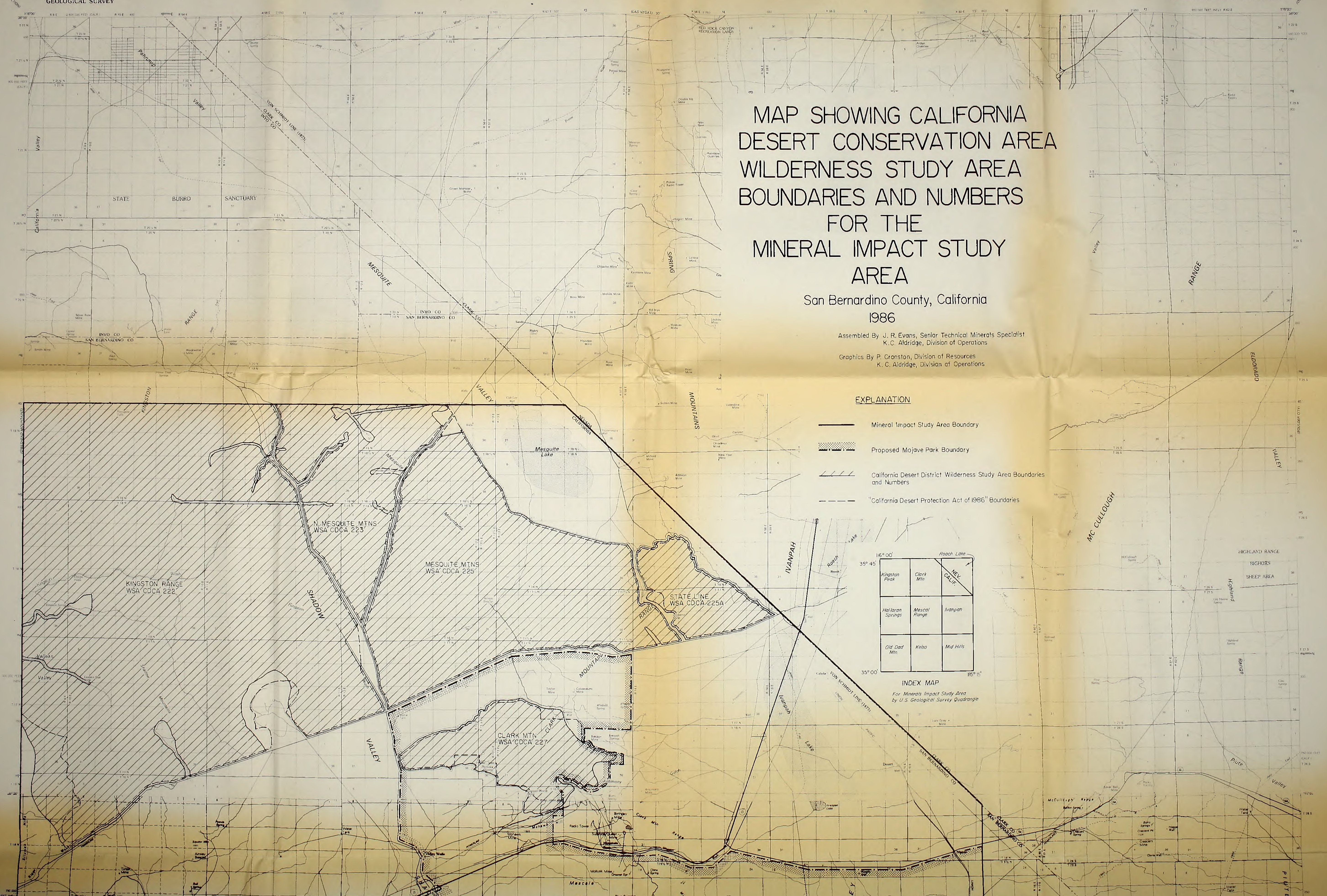
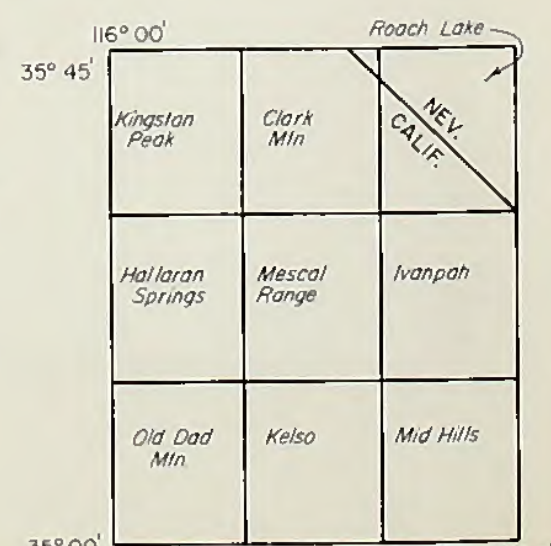
San Bernardino County, California  
1986

Assembled By J. R. Evans, Senior Technical Minerals Specialist  
K. C. Aldridge, Division of Operations

Graphics By P. Cranston, Division of Resources  
K. C. Aldridge, Division of Operations

### EXPLANATION

- Mineral Impact Study Area Boundary
- Proposed Mojave Park Boundary
- California Desert District Wilderness Study Area Boundaries and Numbers
- "California Desert Protection Act of 1986" Boundaries





HOLLOW HILLS  
WSA CDCA 228

Proposed Mojave Park  
Boundary

Proposed Mojave Park  
Boundary

Produced by the Geological Survey  
in cooperation with the Bureau of Land Management  
Compiled from USGS 1:62,500-scale topographic maps dated 1955-56  
Planimetry revised from aerial photographs taken 1973  
and other source data. Revised information not field checked  
Map dated 1977  
Projection and 10 000-meter grid, zone 11,  
Universal Transverse Mercator  
50 000-foot grid ticks based on California coordinate system,  
zone 5, and Nevada coordinate system, east zone  
1927 North American Datum  
To place on the predicted North American Datum 1983 move  
the projection lines 3 meters north and 74 meters east  
Dashed gray lines indicate protected land lines  
There may be private inholdings within the boundaries of  
the National or State reservations shown on this map

INDEX TO 1:62,500-SCALE MAPS

1	2	3	4
5	6	7	8

Kelso Dunes  
WSA CDCA 250

Kelso Dunes  
WSA CDCA 250

N. PROVIDENCE MTNS  
WSA CDCA 263

N. PROVIDENCE MTNS  
WSA CDCA 263

SHADOW VALLEY  
WSA CDCA 235A

SHADOW VALLEY  
WSA CDCA 235A

VALLEY NEW

VALLEY NEW

MAGEE / ATKINS  
WSA CDCA 237

MAGEE / ATKINS  
WSA CDCA 237

DEER SPRINGS

DEER SPRINGS

WSA CDCA 237B

WSA CDCA 237B

WSA CDCA 237A

WSA CDCA 237A

WSA CDCA 238A

WSA CDCA 238A

TEUTONIA PEAK

TEUTONIA PEAK

CINDER DUNES  
WSA CDCA 239

CINDER DUNES  
WSA CDCA 239

NEW YORK MTNS  
WSA CDCA 265

NEW YORK MTNS  
WSA CDCA 265

RAINBOW WELLS  
WSA CDCA 244

RAINBOW WELLS  
WSA CDCA 244

WASA CDCA 238B

WASA CDCA 238B

EIGHT-MILE TANK  
WSA CDCA 245

EIGHT-MILE TANK  
WSA CDCA 245

MID HILLS  
WSA CDCA 269

MID HILLS  
WSA CDCA 269

OLD DAD MTNS  
WSA CDCA 243

OLD DAD MTNS  
WSA CDCA 243

TABLE MTNS  
WSA CDCA 270

TABLE MTNS  
WSA CDCA 270

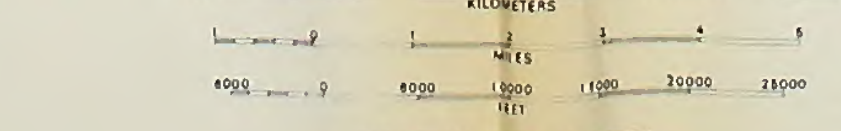
MARL MTNS

MARL MTNS

WOODS MTNS  
WSA CDCA 271

WOODS MTNS  
WSA CDCA 271

SCALE 1:100 000



ELEVATIONS SHOWN IN METERS  
NATIONAL GEODETIC DATUM OF 1973  
To convert elevations in feet multiply by 0.3048



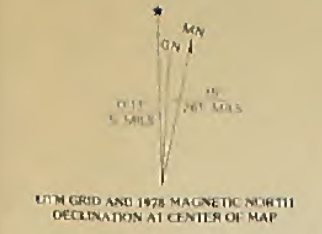
LEGEND

Village or locality  
Landmark building  
Paralleled stream, lake  
Intermittent stream, lake

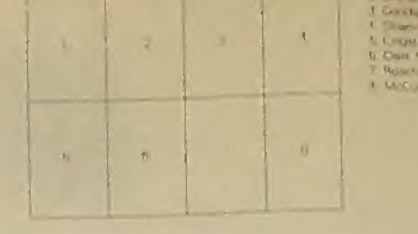
ROAD CLASSIFICATION

Primary highway, hard surface  
Secondary highway, hard surface  
Light-duty road, hard or improved surface  
Screen or other road  
Trail  
Bicentennial roads

U.S. route  
State route



INDEX TO 1:62,500-SCALE MAPS



# MAP SHOWING SURFACE-MINERAL MANAGEMENT STATUS IN THE MINERAL IMPACT STUDY AREA

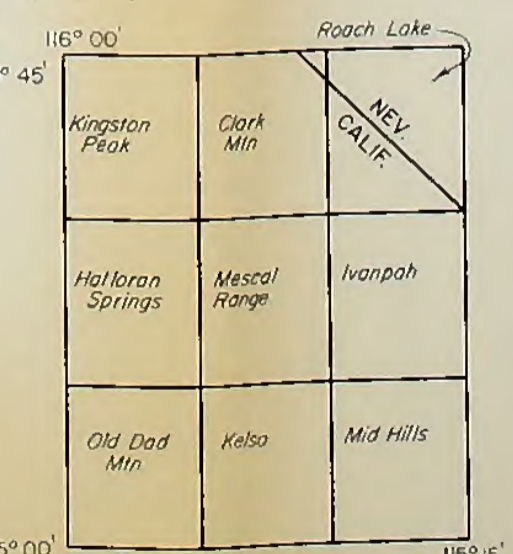
San Bernardino County, California  
1986

**EXPLANATION**

Privately Owned Lands		39,040 ac., 61 sq. mi., 3%
California State Lands		47,153 ac., 74 sq. mi., 4%
California State Reserved Mineral Lands		14,388 ac., 23 sq. mi., 1%
Public Lands		1,170,918 ac., 1830 sq. mi., 92%
Federally Reserved Mineral Estate Lands		8501 ac., 13 sq. mi., 0.7%
Public Water Reserves		1000 ac., 1.6 sq. mi., 0.08%
Oil & Gas Leases		450,554 ac., 704 sq. mi.; 492 leases; 35%
Mining Claims (No. per section)		352,650 ac.; 551 sq. mi.; 8646 claims; 28% (figures include lode/placer claims and mill sites)
Mineral Impact Study Area Boundary		1,280,000 ac., 2000 sq. mi.

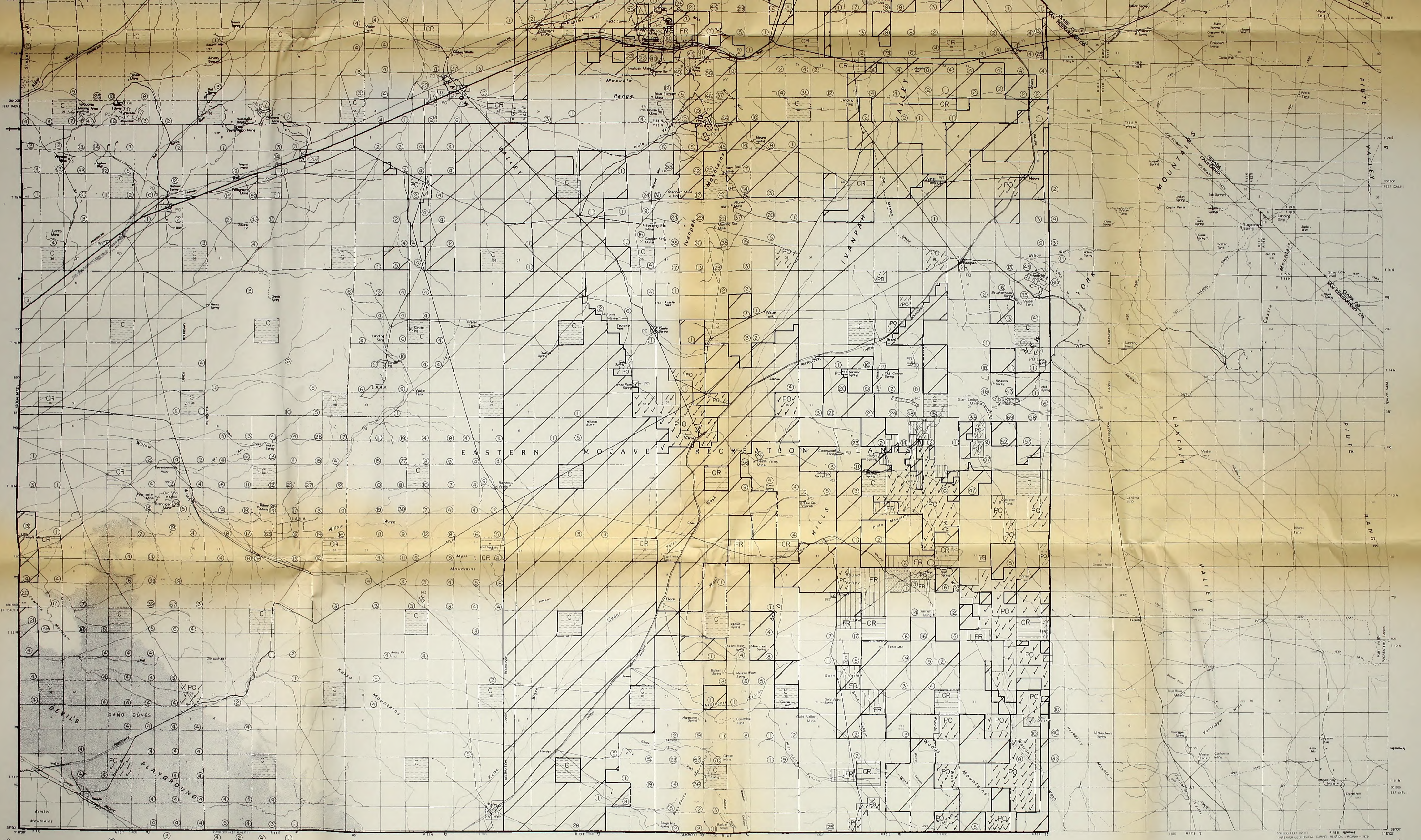
**DATA SUMMARY (approximate)**

Prepared By: J. R. Evans,  
Senior Technical Minerals Specialist  
Data Analysis and Graphics By: K. C. Aldridge,  
Division of Operations  
Data Assembled By: P. Cranston, Division of Resources,  
R. Fairbanks, Chief, Locatable Minerals,  
B. Gauthier-Warner, Land Law Examiner



INDEX MAP  
For Minerals Impact Study Area  
by U.S. Geological Survey Quadrangle

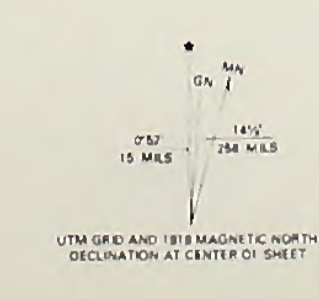




Produced by the Geological Survey  
 in cooperation with the Bureau of Land Management  
 Compiled from USGS 1:62,500-scale topographic maps dated 1955-56  
 and other source data. Revised information not field checked  
 Map dated 1979  
 Projection and 10 000-meter grid, zone 11,  
 Universal Transverse Mercator  
 50 000-foot grid ticks based on California coordinate system,  
 zone 5, and Nevada coordinate system, east zone  
 1977 North American Datum  
 To place on the predicted North American Datum 1983 use  
 the projection lines 3 meters south and 76 meters east  
 Dashed gray lines indicate projected land lines  
 There may be private inholdings within the boundaries of  
 the National or State Reservations shown on this map

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10	11	12



ELEVATIONS SHOWN IN METERS  
 NATIONAL GEODESIC VERTICAL DATUM OF 1985  
 To convert meters to feet multiply by 3.28084  
 To convert feet to meters multiply by 0.3048

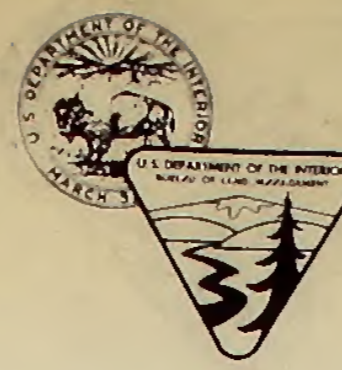


LEGEND

Village or locality	Primary highway, hard surface
Landmark building	Secondary highway, hard surface
Perennial stream, lake	Light duty road, hard or improved surface
Intermittent stream, lake	Street or other road
	Trail
	Interstate route
	U.S. route
	State route

This map complies with national map accuracy standards  
 FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092

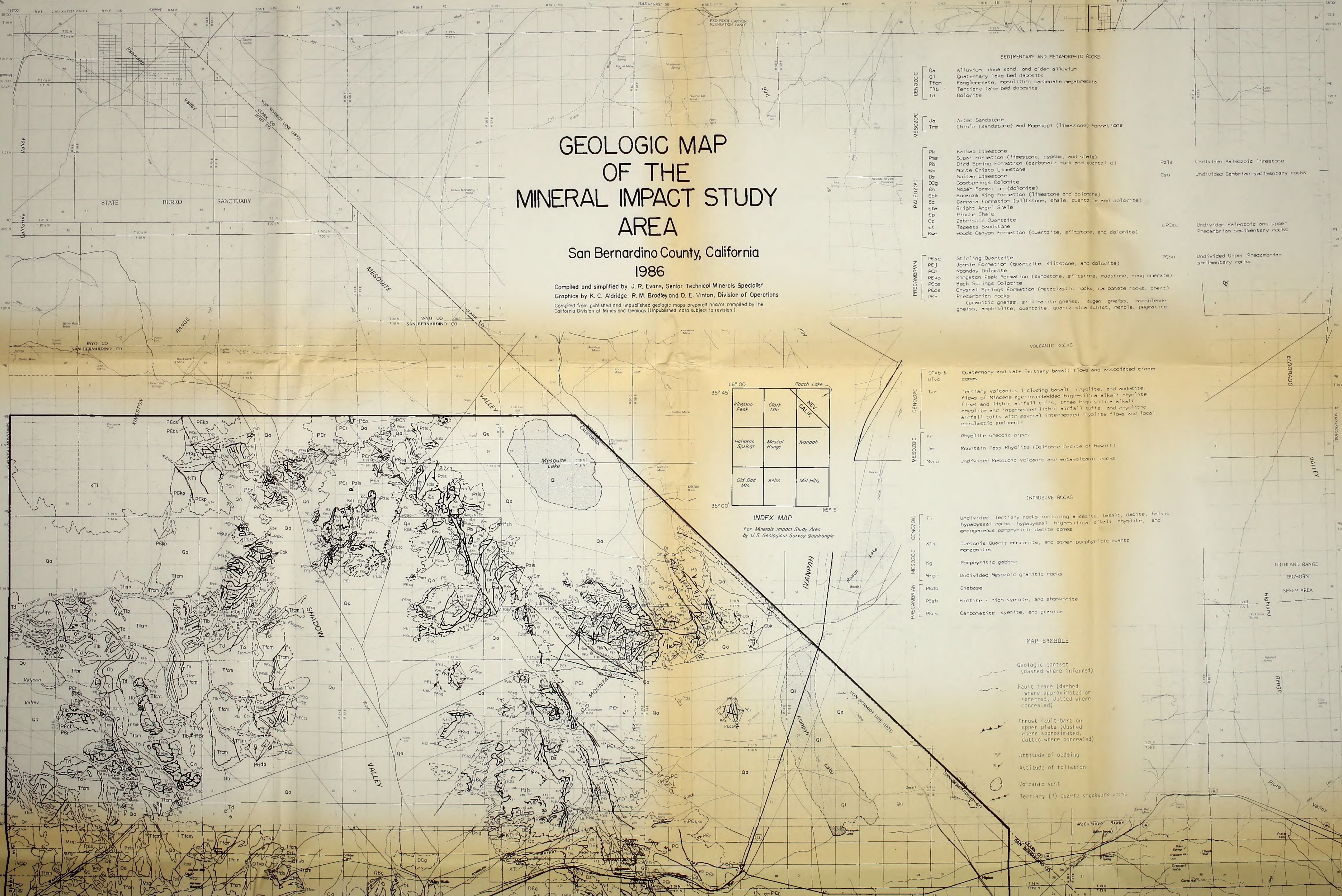
IVANPAH, CALIF. - NEV.  
 1:100,000-SCALE MAP  
 NS500 - W11500/30x50  
 1979



# GEOLOGIC MAP OF THE MINERAL IMPACT STUDY AREA

San Bernardino County, California  
 1986

Compiled and simplified by J. R. Evans, Senior Technical Minerals Specialist  
 Graphics by K. C. Aldridge, R. M. Brodley and D. E. Vinton, Division of Operations  
 Compiled from published and unpublished geologic maps prepared and/or compiled by the  
 California Division of Mines and Geology. (Unpublished data subject to revision.)



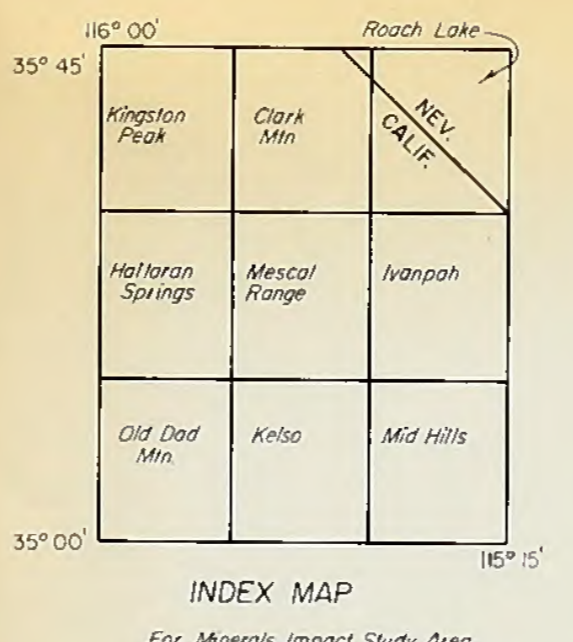
SEDIMENTARY AND METAMORPHIC ROCKS	
Qa	Alluvium, dune sand, and older alluvium
Q1	Quaternary lake bed deposits
Tfcm	Fanglomerate, monolithic carbonate megabreccia
Tlb	Tertiary lake bed deposits
Td	Dolomite
Ja	Aztec Sandstone
Tm	Chinle (sandstone) and Moenkopi (limestone) Formations
Pk	Karlsbad Limestone
Pm	Supai Formation (limestone, gypsum, and shale)
Pb	Bird Spring Formation (carbonate rock and quartzite)
Em	Monte Cristo Limestone
Ds	Sulzen Limestone
Dq	Geopline Dolomite
En	Napa Formation (dolomite)
Ebk	Bonanza King Formation (limestone and dolomite)
Ec	Carson Formation (siltstone, shale, quartzite and dolomite)
Ebb	Bright Angel Shale
Ep	Pioche Shale
Ez	Zabriskie Quartzite
Et	Tapeats Sandstone
Ewc	Woods Canyon Formation (quartzite, siltstone, and dolomite)
Pcsu	Undivided Paleozoic and Upper Precambrian sedimentary rocks
PCsu	Undivided Paleozoic and Upper Precambrian sedimentary rocks

VOLCANIC ROCKS	
QTVb & QTVc	Quaternary and Late Tertiary basalt flows and associated cinder cones
Tvr	Tertiary volcanics including basalt, rhyolite, and andesite, flows of Miocene age, interbedded high-silica alkali rhyolite flows and lithic airfall tuffs, three high silica alkali rhyolite and interbedded lithic airfall tuffs, and rhyolitic airfall tuffs with several interbedded rhyolite flows and local epiclastic sediments
Kr	Rhyolite breccia pipes
Jnr	Mountain Pass Rhyolite (Delfonte Dike of Hewitt)
Mrvu	Undivided Mesozoic volcanic and metavolcanic rocks

INTRUSIVE ROCKS	
Tv	Undivided Tertiary rocks including andesite, basalt, diorite, felsic hypabyssal rocks, hypabyssal high-silica alkali rhyolite, and endogenous porphyritic dacite domes
Kt1	Tuconite Quartz monzonite, and other porphyritic quartz monzonites
Kg	Porphyritic gabbro
Mgr	Undivided Mesozoic granitic rocks
Pcdb	Diorase
Pcsh	Biotite - rich syenite, and shonkinite
Pccs	Carbonatite, syenite, and granite

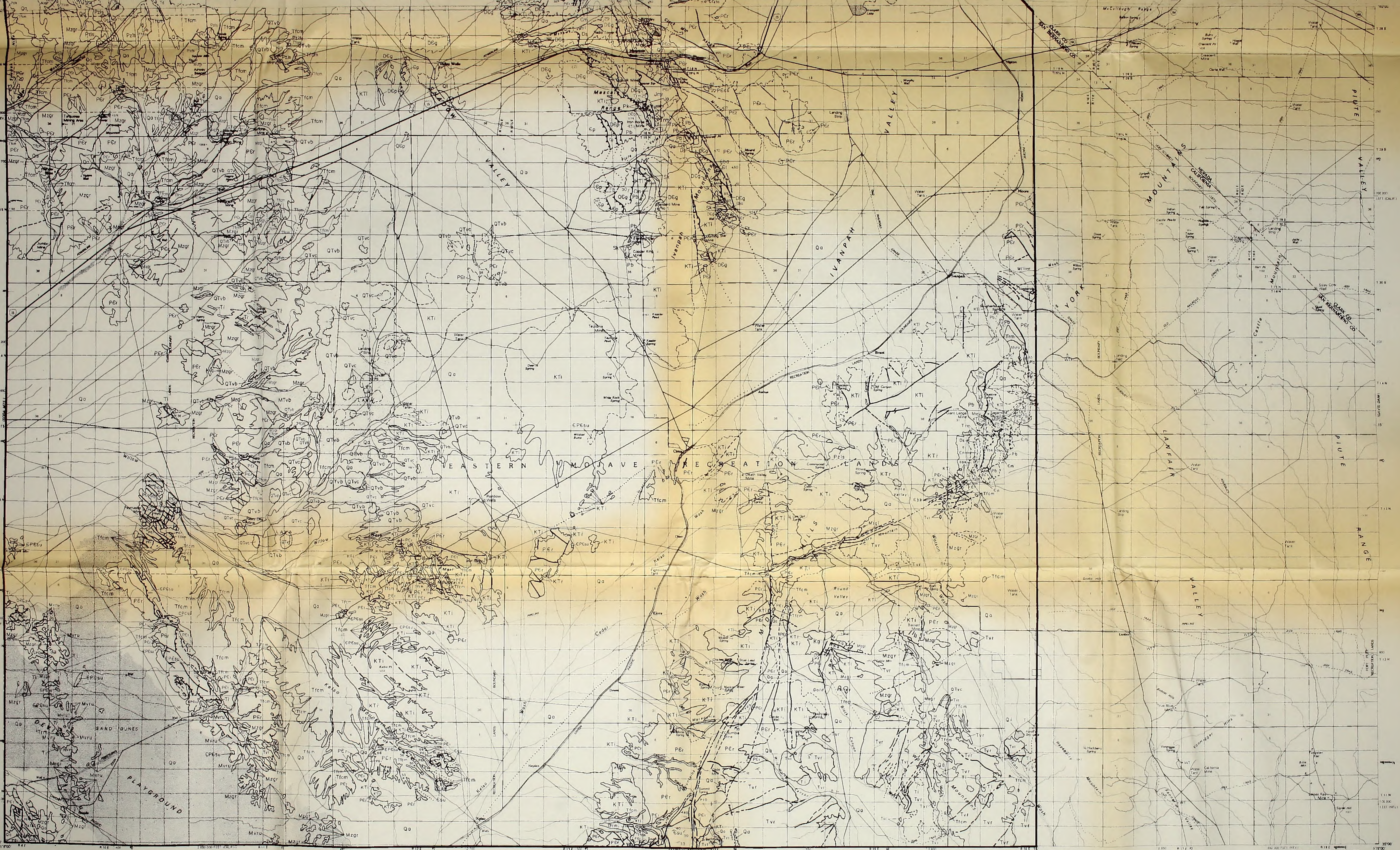
MAP SYMBOLS

- Geologic contact (dashed where inferred)
- Fault trace (dashed where approximated or inferred, dotted where concealed)
- Thrust fault-belt on upper plate (dashed where approximated, dotted where concealed)
- Attitude of bedding
- Attitude of foliation
- Volcanic vent
- Tertiary (?) quartz stockwork dikes



INDEX MAP  
 For Mineral Impact Study Area  
 by U.S. Geological Survey Quadrangle



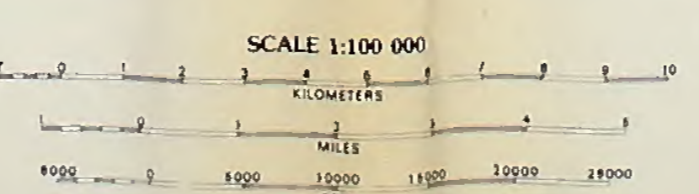
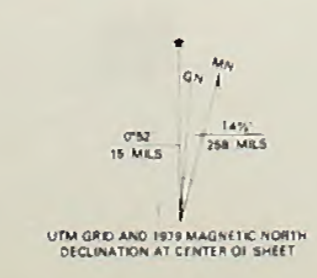


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ELEVATIONS SHOWN IN METERS  
 NATIONAL GEODESIC PHYSICAL DATUM OF 1983  
 To convert meters to feet multiply by 3.2808  
 To convert feet to meters multiply by 0.3048



**LEGEND**

- Village or locality
- Landmark building
- Perennial stream, lake
- Intermittent stream, lake

**ROAD CLASSIFICATION**

- Primary highway, hard surface
- Secondary highway, hard surface
- Light duty road, hard or improved surface
- Street or other road
- Trail
- Interstate route
- U.S. route
- State route

This map complies with national map accuracy standards  
 FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092

IVANPAH, CALIF.-NEV.  
 SWR KINGMAN, INE 1:100,000-SCALE MAP  
 N3500 W11500/30660  
 1979

UNITED STATES  
 DEPARTMENT OF THE INTERIOR  
 GEOLOGICAL SURVEY

MESQUITE LAKE QUADRANGLE  
 NEVADA—CALIFORNIA  
 1:100,000-SCALE SERIES (PLANIMETRIC)

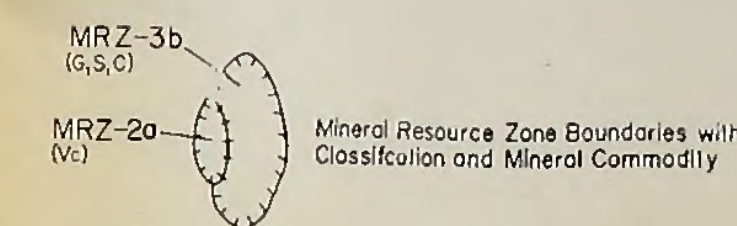
# MAP SHOWING MINERAL LAND CLASSIFICATION OF THE MINERAL IMPACT STUDY AREA

San Bernardino County, California  
 1986

### EXPLANATION

Metallic		Nonmetallic	
G	Gold	CO <sub>3</sub>	Carbonate Rocks
C	Copper	Ma	Magnesite
LZS	Lead-Zinc-Silver	Se	Sericite
S	Silver	Cl	Clay
T	Tungsten	Pe	Perlite
M	Molybdenum	SQ	Silica
I	Iron	Vc	Volcanic cinders
T	Tin	Ta	Talc
RE	Rare-Earths	Fl	Flourite
A	Antimony	Ba	Barite
		Gy	Gypsum
		Mi	Mica
		Ba	Bentonite

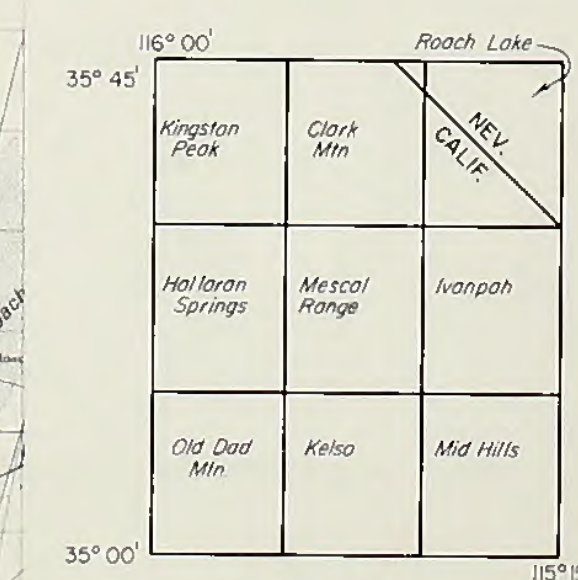
● LZS Mine or Mineral Deposit Showing Mineral Commodity



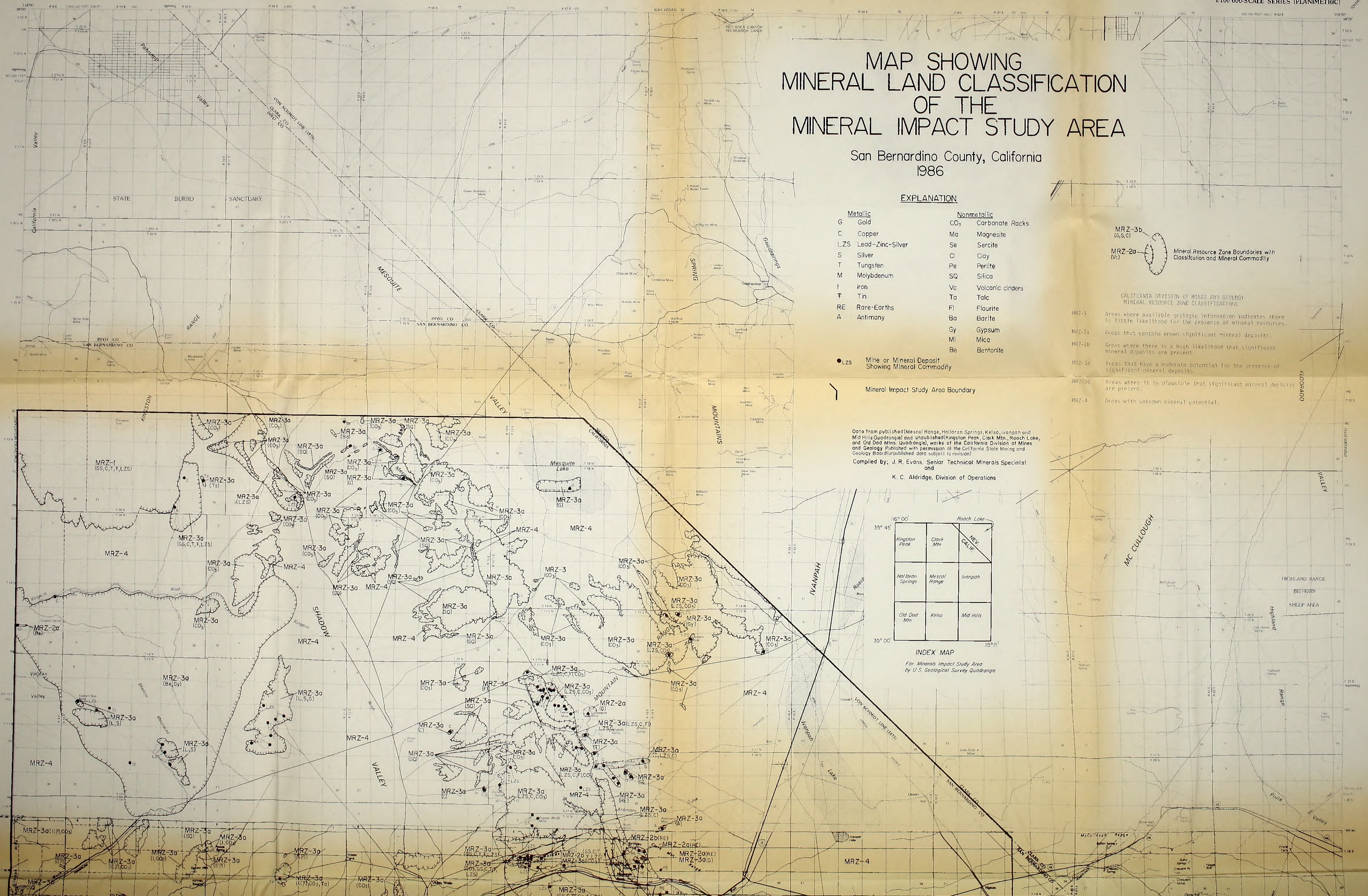
### CALIFORNIA DIVISION OF MINES AND GEOLOGY MINERAL RESOURCE ZONE CLASSIFICATIONS

- MRZ-1 Areas where available geologic information indicates there is little likelihood for the presence of mineral resources.
- MRZ-2a Areas that contain known significant mineral deposits.
- MRZ-2b Areas where there is a high likelihood that significant mineral deposits are present.
- MRZ-3a Areas that have a moderate potential for the presence of significant mineral deposits.
- MRZ-3b Areas where it is plausible that significant mineral deposits are present.
- MRZ-4 Areas with unknown mineral potential.

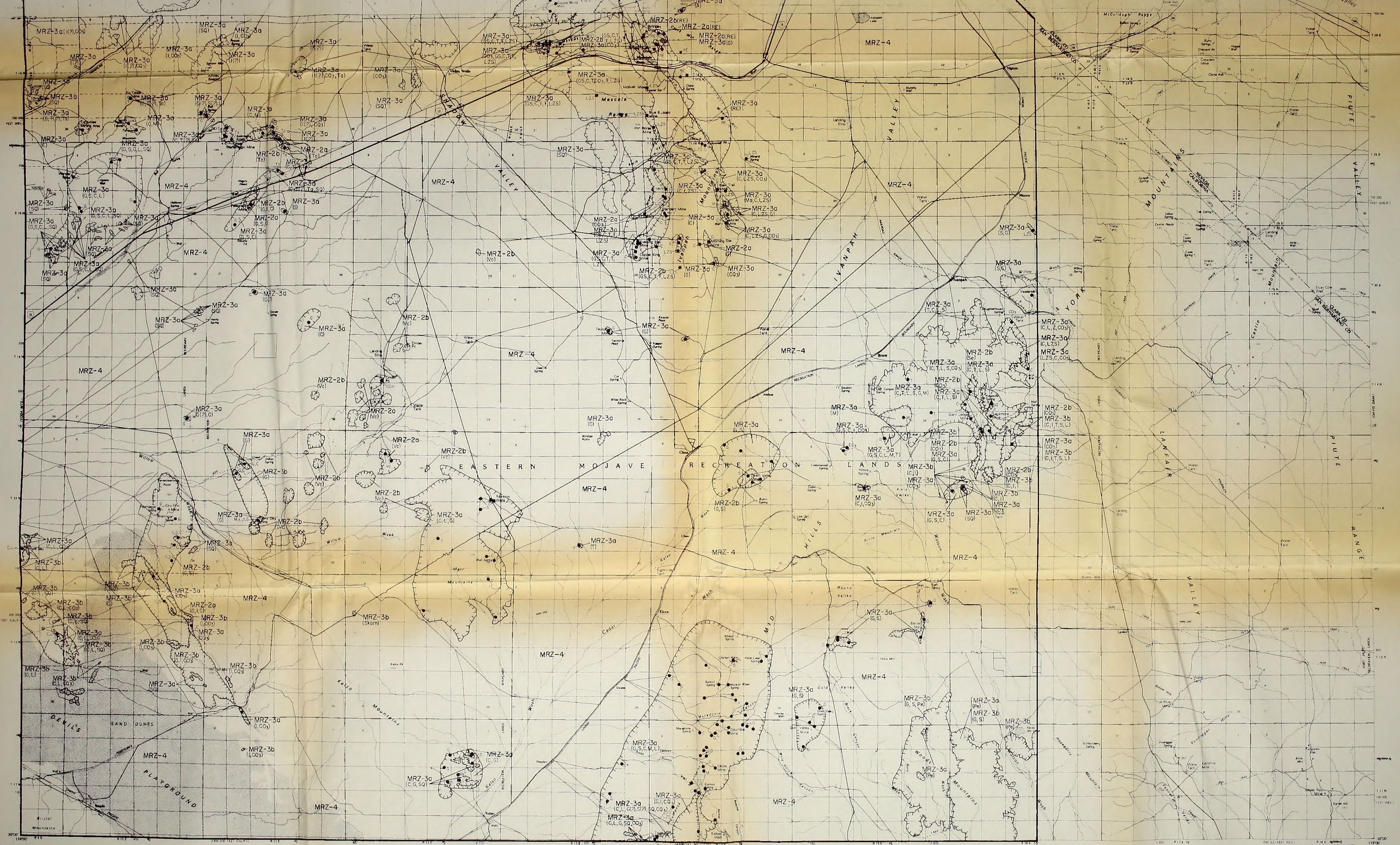
Data from published (Mesquite Lake, Halloran Springs, Kelso, Ivanpah and Mid Hills Quadrangles) and unpublished (Kingston Peak, Clark Mtn., Roach Lake, and Old Dad Mtn. Quadrangles), works of the California Division of Mines and Geology. Published with permission of the California State Mining and Geology Board (unpublished data subject to revision).  
 Compiled by: J. R. Evans, Senior Technical Minerals Specialist and  
 K. C. Aldridge, Division of Operations



INDEX MAP  
 For Minerals Impact Study Area  
 by U.S. Geological Survey Quadrangle



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 DENVER, FEDERAL CENTER  
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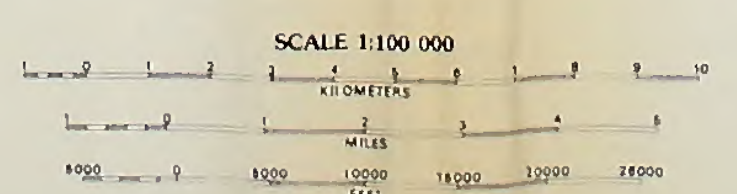


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  - Secondary highway, hard surface
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IVANPAH, CALIF. - NEV.  
 1:62,500 SCALE MAP  
 N5300-W11500/3060  
 1979



Form 1279-3  
(June 1984)

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area of the East Moja

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